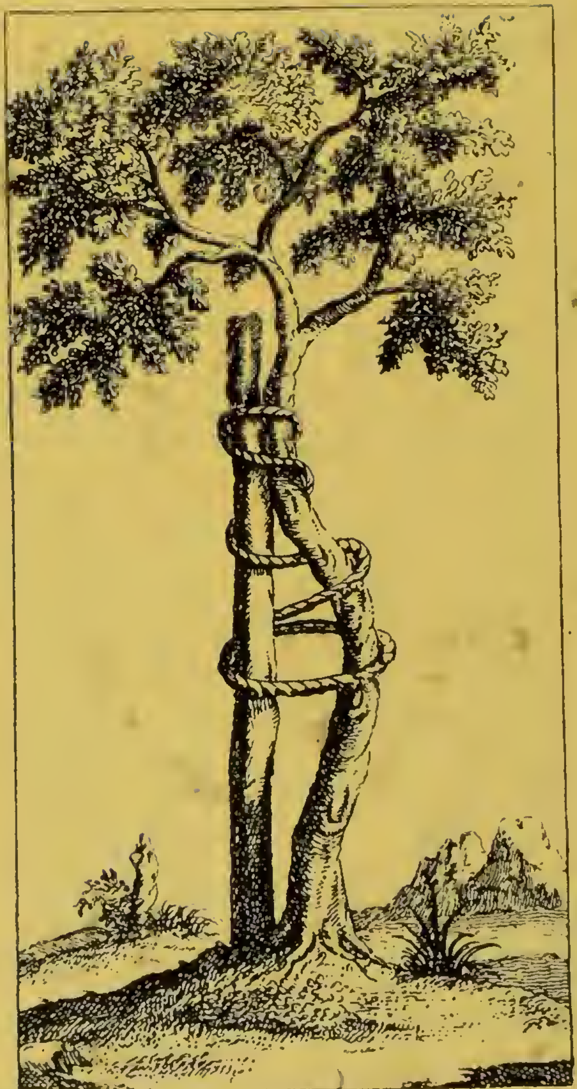

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HANDBOOK

OF

SURGERY

BY

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PREFACE

The appearance of another book on Surgery for students among so many excellent manuals already in existence may seem to require some explanation. It appears, however, that there is a demand for a short handbook, corresponding somewhat to the earlier editions of "Walsham"; and the publisher who asked me to undertake the work assured me that there were frequent inquiries for something of the kind from those who wished to revise the surgery they had already learnt, before presenting themselves for examination.

Such a book is necessarily in great part a work of compilation; and for this purpose I have chosen those textbooks and monographs which are accepted as amongst the best standard authorities. I desire, therefore, to acknowledge my indebtedness to them, and hope that their authors will consider the references here given as sufficiently indicative of the sources of many of the particulars, since it has been found impossible, except in a few instances, to acknowledge them in the text.

In the first place I have based the scheme of the book on the two outstanding English textbooks, Walsham and Spencer's *Theory and Practice of Surgery*, and Treves's *System of Surgery*. On the first of these I have in addition drawn freely for the arrangement, and to some extent for the details, in the sections on *General Surgical Processes*, *Tumours*, *Fractures*, *Dislocations*, and *Diseases of the Breast*. To the second, and the authors of the respective articles, I am beholden for much of the sections on the *Head*, *Neck*, *Thorax*, *Abdomen*, *Rectum*, and *Urinary Organs*.

I have also referred for special subjects to Muir and Ritchie's *Manual of Bacteriology*, Schimmelbusch's *Aseptic Treatment of Wounds*, Jon. Hutchinson's *Syphilis*, Bland Sutton's *Tumours, Innocent and Malignant*, Helferich and Hutchinson's *Fractures and Dislocations*, Macewen's *Pyogenic Diseases of the Brain*, Kocher's *Operative Surgery* (*Neck*), Lennander's *Sensibility of the Abdomen* (trsl. Barker), Soltau Fenwick's *Diseases of the Stomach*, Kelly and Hurdon's *Appendix and its Diseases*, Sultan and Coley's *Atlas of Abdominal Hernias*, Mayo Robson's, Moynihan's, and Kehr's works on affections of the *Gall-bladder* and the *Pancreas*, H. Fenwick's *Urinary Surgery*, and Keetley's *Orthopædic Surgery*.

To Rose and Carless's *Manual of Surgery* I am indebted for part of the section on the *Spine* ; and to Lexer's *Algemeine Chirurgie* for much in the sections on *Diseases of Bones and Joints*, especially as relating to their pathological anatomy. I have also throughout made free reference to the *System of Practical Surgery* by Bergmann, Bruns, and Mikulicz, latterly in its English translation by Bull ; and also to Testut and Jacob's *Anatomie Topographique*. Further, I have to acknowledge my indebtedness for various isolated papers, personal communications, or lectures, to Sir Wm. Macewen ; Dr. J. C. Renton, of Glasgow ; Prof. Bier, of Bonn ; Prof. Helferich, of Kiel ; Prof. Roux, of Lausanne, and others.

Recognising that views of treatment differ so materially amongst various teachers, those parts throughout the book which deal with it have been touched on lightly, and are meant more as indications of the general principles to be adopted than as categorical directions. Except for the main points, no attempt has been made, therefore, to give full descriptions of operations, for which the student is referred to a work specially on Operative Surgery ; exceptions have been made in one or two instances, however, where the operation is one likely to be required frequently on the part of the general practitioner. And all references to the special subjects of the *Eye*, *Ear*, *Nose*, *Throat*, and *Diseases of Women*, have been omitted, except in so far as they trench on the domain of general surgery.

Finally, I have to tender my sincere thanks to those gentlemen who have so kindly aided me in the laborious task of revising the proof-sheets ; in particular, to Mr. C. W. Cathcart, for his advice on many points ; to Dr. John Morton, for his correction of the anatomy ; to Dr. John Guthrie for his careful revision of the text ; and to the Publisher, who has furthered the progress of the book with his enthusiasm and help.

G. B. BUCHANAN.

13 Buckingham Terrace,
Glasgow, *April* 1906.

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HANDBOOK OF SURGERY.

SECTION I.

GENERAL SURGERY.

CHAPTER I.

INFLAMMATION—SUPPURATION—ULCERATION—GANGRENE.

INFLAMMATION.

Inflammation is the immediate series of changes which occur in the tissues as a result of injury, provided it is not severe enough to destroy them at once. The **injury** may be **thermal**, such as burns and frost-bites; or **mechanical**, such as bruising, tearing, and friction of foreign bodies; or **chemical**, from extraneous sources, such as strong antiseptics, or from waste products of metabolism of the body tissues, or more commonly, from the action of microbes and their products, or from the disintegration of dead tissues.

Predisposing conditions depend on the impaired *quality* of the blood supplied to the part, due to improper food, want of fresh air, anæmia, diabetes, Bright's disease, alcoholism, to gout, tuberculosis, and syphilis, or to poisoning with lead or mercury; and on the impaired *quantity*, owing to vascular obstruction, or weak action of the heart, or on the disturbance of the nervous supply to the part interfering with its normal circulation and functions.

The Phenomena of Inflammation are as follows: –

1. Dilatation of all the vessels of the part, due probably to direct local paralysing action of the irritant on the cells of the vessel walls, and also a reflex action on the central vasomotor centres.

2. Slowing and stasis of the circulation within the area of inflammation, with a tendency for the leucocytes to gather on the walls of the vessels, which are still dilated.

3. Exudation of the fluid part of the blood, which is more or less coagulable according to the vascular tension and the condition of the vessel walls.

4. Passive exudation of red corpuscles (*diapedesis*) and some leucocytes, from paralysis of the vessel walls, and partly from pressure in them.

5. Active emigration of leucocytes (which, when found outside the vessel walls in an inflamed area associated with pyogenic conditions, are known as pus cells).

6. Increase in number of fixed cells of the area by kariokinetic division. They become cloudy, from infiltration of albuminous material into the protoplasm. Sometimes fatty degeneration takes place. On epithelial surfaces these changes lead to desquamation.

Repair.—In inflammation of long duration and of not too great intensity new formation of tissue occurs. *Granulations* are formed, which are composed of round cells, consisting of (*a*) leucocytes, and (*b*) larger epithelioid cells with oval nuclei, derived chiefly from connective tissue cells, and which ultimately become *fibro-blasts.* They are embedded in a reticulum, and permeated with a network of capillary vessels, which spring from the ends of existing vessels as solid buds. These form loops and become hollowed out to form new capillaries. Later, the round cells become spindle-shaped, and their fibrous ends interdigitate with neighbouring cells. They tend to shrink after a time, and *cicatrization* is said to take place. Pressure of the tissues due to cicatricial shrinking causes many of the new-formed blood-vessels to become obliterated, and the part is thus left avascular. Nerves also may be implicated in the contraction, and irritation and pain, or destruction and paralysis, may ensue.

Inflammation and Repair of Special Tissues.

Epithelium is repaired by multiplication of existing cells in the vicinity. *Hair* and *nails* are regenerated from existing roots. In *muscle* and *tendon*, repair takes place chiefly by fibrous tissue filling up any gap. In inflammation of *bone*, the osteophytes become active, and absorption of the bone channels takes place to some extent, leading to porosis; and in repair, a corresponding activity of bone formation occurs, and the bone subsequently is left dense. Loss of substance is frequently made up by development of bone from the periosteum. Inflammation of *gland* tissue causes subsequent hardening from fibrous deposit, but there may be proliferation of gland cells, also, as in the liver and kidney.

Peripheral *nerves* are repaired by development of existing nerve cells; but in the central nervous system the cells do not show any tendency to regeneration. In inflammation in the central nervous cavities the consequent œdema often gives rise to dangerous pressure effects.

If a foreign body or dead piece of tissue gives rise to inflammation and is absorbable, it is invaded by leucocytes and granulation tissue; it becomes absorbed, and eventually replaced by new tissue, which shows the usual tendency to cicatrization. If the body is non-absorbable, it is surrounded by granulations and becomes *encapsuled* instead; if it is septic, an abscess forms round it.

Terminations of Inflammation.

(*a*) **Resolution**, *i.e.* subsidence of all the phenomena, when the irritation ceases to act. The exudation of serum and leucocytes is absorbed by the lymphatics; fibrinous exudation becomes liquefied and also absorbed, and some of the fixed cells disappear in fatty degeneration. The vascular system, and the function of the part, are restored to their normal conditions.

(*b*) **Adherence** of inflamed surfaces, from coalescence of adjacent layers of granulation tissue.

(*c*) **Induration** in the more chronic forms, when there is a large mass of new-formed tissue, with a tendency to contract.

(*d*) **Necrosis** or death of a piece of tissue, due to a surrounding zone of inflammatory stasis cutting off the blood-supply to the part.

(*e*) **Suppuration.**—(*Vide* p. 6.)

Symptoms of Acute Inflammation.

(*a*) **Local.**—Heat and redness are usually present, and are due to the increased blood-supply of the part. The greater flow also causes at first increased secretion of the glands in the vicinity supplied by the same vessels, but this diminishes as stasis ensues. Swelling is almost constant, and is due to hyperæmia and effusion of serum; it shows pitting on pressure. Pain, which is usually throbbing in character, is due to pressure on nerve-endings by distended vessels and effused fluid.

(*b*) **General.**—Rigors are often the earliest signs, varying from a feeling of chilliness to a fit of shivering. There is usually headache, the eyes are suffused, the bowels constipated, the appetite is lost, the tongue white and furred, the skin dry and hot, and the urine high coloured and scanty. The temperature rises in proportion to the severity of the inflammation, 99°-103° F. or higher. In cases of suppuration the temperature curve is often characteristic, with high fever at night and deep remissions in the morning. The pulse is full and bounding, and its rate is increased. There may be delirium. In weak patients or in long-continued inflammations, *asthenic or typhoid symptoms* appear; when the pulse is soft and weak, the tongue covered with dark sordes, the lips are cracked, diarrhœa frequently ensues, and a tendency to formation of bed-sores, heart failure, œdema of the lungs, or constant delirium is common.

Treatment of Acute Inflammation.

(*a*) **Local.**—Remove the cause of irritation; relieve tension, by opening abscesses, removing foreign bodies, etc. Favour return of normal blood-supply to the part, by rest, elevation of a limb; application of cold in the early stages by ice, Leiter's tubes, or evaporating lotions, care being taken to avoid lowering the vitality of the tissues by an excessive degree or length of application. Heat and moisture, in the form of aseptic fomentations, may be used to dilate superficial vessels, in order to relieve tension, and with it the pain. In some cases local bleeding is of use for the same purpose. Astringent lotions are useful to constrict superficial vessels in mucous surfaces.

(*b*) **Constitutional.**—A brisk purge is given to empty the bowels and prevent absorption of toxic waste-products by the colon. The diet is restricted to light and easily digested food, generally liquids, as long as the digestion is impaired; diaphoretics and diuretics may be given to eliminate waste products by the skin and kidneys. Opium is used (i.) to relieve pain, (ii.) to promote sleep, and (iii.) to diminish secretion, when desired.

In asthenic inflammation, stimulation should be employed—the diet consisting of strong soups, and nourishing and digestible food in larger quantity, compatible with the powers of digestion. Nutrient enemata may be given, and strychnine and alcohol in frequent small doses, when the heart is weak.

Chronic Inflammation.—The process is the same as in the acute form, but the source of irritation remains for a long time and is usually less virulent. So, also, the dilatation of the vessels continues, proliferation of fixed cells progresses, with continued emigration of leucocytes, while new vessels are developed. The causes are often to be found in tuberculosis, syphilis, gout, and rheumatism, in certain kinds of poisoning; in passive congestions, causing the nutrition of the cells to be impaired: or to continued infection of surfaces by pyogenic microbes.

Symptoms of Chronic Inflammation.—Swelling is marked, due to continuous cell proliferation, exudation, and deposit of fibrous tissue. Redness is less noticeable than in acute inflammation, but the skin is often dusky from congestion, or discoloured from blood pigment liberated by disintegration of red corpuscles. Pain is less severe, but aching in character, and often worse at night. The part is usually warmer than normal.

Constitutionally, the patient often suffers from anaemia and general weakness. There may be signs of gout, rheumatism, tuberculosis, or syphilis.

Chronic inflammation may end in resolution with permanent fibrous thickening, or in suppuration or ulceration.

In Treatment of Chronic Inflammation, the chief object is to remove the cause, promote absorption of inflammatory products, and re-establish the normal circulation and nutrition of the affected part.

Constitutional Treatment.—Nourishing food, fresh air, preferably at the seaside; tonics, and stimulants if the heart is weak; and iodide of potassium in syphilitic and in some non-syphilitic diseases to promote absorption.

Local Treatment consists of massage and movements in the case of adhesions; rest, when the process of repair is not fully established; constant pressure by cotton or rubber bandages, or by strapping; of application of iodine, mercury, or blisters; and of local congestion by Bier's elastic bandaging. This consists in fastening one or two turns of elastic bandage round a limb just tight enough to cause blueness and swelling. If pain is produced, or if the arterial circulation is stopped, the bandage must at once be loosened or removed. It may be applied for two to twenty-two hours a day depending on the effect produced. A firm bandage may be applied to the unaffected lower part of a limb to prevent unnecessary œdema at that place.

SUPPURATION.

Suppuration.—In the presence of pyogenic microbes inflammation usually goes on to suppuration instead of resolution. Leucocytes are effused in increasing numbers, and tend to degenerate and die. The toxins produced by the organisms exert a digestive action on the leucocytes and the cells of the neighbouring tissues, and thus *pus* is formed, consisting of *liquor puris*, *i.e.* blood serum, and pus cells. The neighbouring fixed cells become infiltrated with fibrinous exudation, and die (*coagulation necrosis*); the cells are then broken up and form part of the pus. The more resistant structures withstand this solvent action and are separated as *sloughs*.

Pus from an acute abscess is a thick, creamy, odourless fluid, alkaline in reaction, with sp. gr. of about 1030. By the microscope it is seen to be composed in large proportion of leucocytes, mostly polymorphonuclear, some of which are alive, but many dead and swollen; there is also a detritus of cell granules, fat, and fibrin. Blood or blood-pigment may be present from erosion of small vessels, then it is said to be *sanious*. Where there is much fibrin (as in cold abscess), it is called *curdy*; *serous*, when it consists largely of serum; and *mucous*, when it is mixed with mucus. When it has a *feculent* odour, that is generally due to bacillus coli.

In old collections of pus the microbes may be dead and no longer infective, and the symptoms, being continued by the toxins only, gradually subside.

An **abscess** is a purulent collection in a cavity hollowed out by the production of pus among the soft tissues. It may be acute or chronic. **Empyema**: a collection of pus in one of the natural cavities of the body.

Pyogenic Membrane.—A name formerly given to the layer of granulation tissue and fibrin lining an abscess cavity of some duration. It forms a protective layer against invasion. In a tubercular abscess this is often studded with tubercles, and may contain many tubercle bacilli.

Miliary Abscess.—Pin-point abscesses formed by a number of separate points of infection, usually from the blood stream; called so from their resemblance to millet seeds. They may increase to any size. (See Pyæmia.)

Cellulitis.—Diffuse suppuration beneath the skin or between the muscular planes.

Chronic or Cold Abscess.—A collection of soft caseous matter *resembling* pus, and formed by the breaking up of the tissue cells, usually by action of bacillus tuberculosis. It may be formed also from an acute abscess in which the microbes have died out.

Purulent Catarrh.—Discharge of pus from mucous membrane or skin.

Cause of Suppuration is practically always pyogenic microbes invading the tissues or wounds, which are not protected by sufficient immunity against their growth and poisons. Small collections of pus cells may be formed from other irritants, but they are not infective.

Symptoms of suppuration are those of acute inflammation with marked local signs. **Constitutionally** there is fever, usually preceded or accompanied by rigors, the temperature being high at night, 100°-103° F., with deep remissions in the morning, but falling rapidly if an abscess is opened. Fever may be absent, especially in some cases of peritonitis and cerebral abscess. *Leucocytosis* is usual, *i.e.* an excessive number of leucocytes, chiefly polymorphonuclear, appear in the blood up to the number of 15,000 to 30,000 per c.mm., depending on the amount of toxin absorption and the resistance of the body. (In very powerful infections this is not seen—*negative chemiotaxis.* There is also a physiological leucocytosis from digestion and muscular exertion, which must be avoided by taking the blood count at suitable times.) (Glycogen reaction is seen in the cells and fluid of the blood in suppuration.

Locally there is pain and throbbing, increased by anything that raises the blood pressure in the part; local tenderness; œdema, with pitting of the surface on pressure,—a sign of great importance in deep-seated suppurations, as in bone; swelling, at first diffuse, becoming more localised at one point; redness and softening increasing; fluctuation, where an abscess has formed, sometimes not felt, if the pus lies beneath a dense fascia, when a sensation of resistance may be met with.

Continuation of suppuration leads to a disintegration of the surrounding walls, and a tendency for the abscess to break through at its weakest part: this is called *pointing* when it distends the skin, which becomes thin and dusky in colour. It may finally burst from pressure within and empty itself on to the surface, or in certain positions into one of the cavities of the body; where blood-vessels are involved severe hæmorrhage may take place.

Round an area of suppuration there is always a zone of acute inflammation, less intense the farther it is from the centre of the abscess.

Diagnosis of Suppuration is made from the above symptoms. Sarcoma with involvement of the skin, and hernial protrusions, have been mistaken for suppurations; but there is absence of constitutional signs, and the history is usually clear enough to prevent the mistake. Aneurysms sometimes simulate abscesses; but the pulsation is characteristic.

Terminations of Suppurations:

1. Absorption of pus in small abscesses, with resolution (rare).

2. Rupture of abscess through the skin, with (*a*) healing; (*b*) formation of a sinus, or (*c*) fistula; or into a cavity of the body, or into a vessel.

3. Retention of pus and absorption of its poisons, leading to septicæmia or pyæmia.

Treatment.—As soon as suppuration is diagnosed, a free incision should be made to relieve tension and empty the cavity of pus. An exploratory puncture with a fine trocar is admissible only where the abscess can be opened directly in the line of the needle track, lest the parts penetrated should be infected. All such operations must be done with antiseptic precautions. The cavity may be washed out with an aseptic, unirritating fluid, but without sufficient pressure to cause infection being spread into the softened tissues around. Strong antiseptics must be avoided, as they cannot disinfect the cavity, and they irritate and weaken the natural resistance of the lining cells. Incisions must be free, to empty all pockets of pus, and any septum must be broken down. For suppurations in a part crowded with important delicate structures **Hilton's method** may be used. It consists in cutting through the skin and fascia, then continuing with a blunt instrument, such as a dressing forceps, which can be opened to allow the escape of pus. A director may be used for the same purpose to protect the underlying parts from the point of the knife. Where the abscess is very large a counter-opening may be made to ensure better drainage. If hæmorrhage takes place, pressure may be used, or adrenalin may be applied.

The wound should be packed with gauze for a short time, or a drainage tube inserted, and an antiseptic dressing applied outside.

Chronic Abscess, usually tubercular in origin, forms slowly with few signs except swelling and generally fluctuation. There is usually a distinct wall, lined with smooth granulation tissue, (the so-called pyogenic membrane). It progresses by burrowing towards the most dependent point. A chronic abscess may, after a long quiescent stage, be subjected to injury, when the patient's vitality is lowered, and it may commence to be active again; this is known as *residual abscess.* It becomes readily infected by pyogenic organisms if opened without antiseptic precautions, or it may be infected through the blood stream, and severe toxæmia results. This produces *hectic* fever, and sometimes *amyloid* disease of important organs, with a grave degree of exhaustion.

Diagnosis.—From cysts, simple and malignant tumours, especially lipoma and soft sarcoma. The history of the origin and course is important.

Treatment.—If small, it should be wholly excised with its wall where possible, and treated as a fresh wound; otherwise it should be opened, the lining wall scraped away, and the cavity plugged with iodoform gauze and allowed to granulate from the bottom. The edges may be sewed partially together to hasten healing; or it may be filled with iodoform emulsion or other stimulating fluid, and completely sewed up, and the process repeated if it refills. For very profuse discharge a drainage tube may be used.

Sinus is an open track left by the opening of an abscess on to the skin or mucous membrane, or by an unhealed deep wound. It is continuous with an abscess cavity or suppurating wound, and its lining membrane is similar, being granulation tissue; but the inflammation is less intense, and the tendency to heal is greater.

Cause.—Is usually the presence of a foreign body harbouring microbes, such as a drainage tube left in too long, or a piece of necrosed tissue, especially bone; frequently also tubercle or malignant disease in the walls of the track. The orifice is often hidden in a papilla of exuberant granulation tissue.

Treatment.—Remove the source of irritation, leaving the walls smooth to obviate the lodgment of pyogenic microbes: where possible the whole sinus should be excised and the wound closed. Otherwise it should be treated in the same way as a chronic abscess. In some cases a drainage tube must be inserted, when the wound may be irrigated frequently with a weak antiseptic lotion, to act (*a*) by removing pus mechanically, and (*b*) by stimulating the discharge of serum with the same object in view. Hydrogen peroxide by its effervescence acts in the same way. Astringents may be used to keep down granulations and so prevent the retention of microbes. Copper sulphate and silver nitrate are useful for this purpose. Further infection is prevented by using antiseptic precautions and covering the parts with a sterile dressing.

Fistula is a track leading from one surface of skin or mucous membrane to another, or from skin to mucous surface: it may be lined with epithelium throughout, unless part of it is ulcerated.

Cause.—(*a*) Congenital, from defective development: (*b*) from accidental injury, with a temporary formation of sinus, becoming later a fistula by the covering of its walls with epithelium; or (*c*) from intentional formation, for the relief of certain symptoms.

Treatment.—Is similar to that of sinus, but excision of the track, with suture of the wound at both surfaces of skin or mucous membrane, is to be preferred.

Cellulitis is suppuration in the loose (cellular) connective-tissue planes of the body, wherever they exist (*vide* Erysipelas, etc.).

Cause.—Pyogenic microbes, pure or mixed with others, the infection occurring from a wound or even a prick, or arising from the spread of an existing abscess.

Pathologically it is similar to suppuration elsewhere, but from lack of limiting tissue it tends to spread rapidly and widely, thus cutting off blood-supply of large tracts and leading to formation of sloughs, and to involve lymphatic vessels and glands early.

Symptoms are those of suppuration with severe constitutional effects from absorption; and the local signs are less, owing to want of tension, the chief being great œdema, redness, and stiffness of surrounding muscles.

Diagnosis.—From simple œdema, myxœdema, and elephantiasis, by the history and special symptoms.

Treatment.—Free incisions into the parts, where necessary, by Hilton's method; drainage by tubes or gauze; aseptic, absorbent, and unirritating dressings; rest; artificial congestion (*Bier*); in severe cases amputation of a limb may be necessary. Constitutionally, nourishing light food, stimulation, and iron tonics.

Suppuration on a surface of mucous membrane, serous membrane, and skin.

(*a*) **Muco-purulent Catarrh.**—Discharge of muco-pus from an inflamed mucous membrane (*vide* Gonorrhœa, Appendicitis, etc.).

Cause.—Microbes are always present as exciting cause; predisposing causes are wounds or irritation, often with passive congestion of the part in addition; or previous destruction of the protective superficial layers of the normal mucous membrane.

Pathologically, it consists of inflammation, with microbes and pus collecting in the deeper layers of mucous membrane and the submucous tissue, and penetrating to the surface. There is at first great increase of secretion of mucus; then degeneration and destruction of the cells which are replaced by round cells; and, finally, by granulation tissue. The surface is covered with necrosing cells and fibrin mixed with mucus.

Symptoms.—Local: in sensitive parts, burning and dryness. General: fever, and other signs of inflammation, loss of function of the part; absorption of toxins, or retention of products.

Terminations.—Resolution, when inflammation subsides, by regeneration of the remaining mucous cells, and replacement from the adjacent ones; loss of mucous membrane, replaced by connective tissue covered with thin layer of squamous epithelium, causing loss of function and weakness of the part against subsequent invasions; cicatrization with shrinking of the new-formed tissue, leading to strictures or to epithelioma; necrosis of mucous membrane (esp. in intestine), leading to extravasation; penetration of microbes through the wall (*e.g.* peritonitis); retention of products (*e.g.* empyema); involvement of important organs or blood-vessels.

Treatment.—Strengthen the general health; and locally apply astringents to the mucous membrane if it is accessible, with drainage of secretion.

(*b*) **Sero-purulent Catarrh.**—Discharge of pus mixed with serum from a serous membrane.

Causes.—Predisposing: anything that weakens the bodily resistance, chill, irritation, exhaustion, etc. Exciting: microbes of various kinds, esp. bacillus coli and diplococcus pneumoniæ.

Pathologically.—It is similar to the preceding, but there is a greater tendency to the production of fibrin, which adheres to the walls, and to formation of adhesions on resolution, where there has been much destruction of serous membrane.

Symptoms.—Pain is striking and sharp, becoming less acute as the parts are covered with fibrin, or the nerve-endings are destroyed. Constitutionally, there are the usual signs of inflammation.

Terminations.—Resolution without loss of function; adhesions or strictures; empyema.

Treatment.—Evacuation of the fluid; rest; absorption of secretion as it is made (*vide* Special Inflammations).

(*c*) **Pustulation.**—Suppuration taking place in minute areas of the deeper layers of the skin. The superficial cells of the *rete Malpighi* are destroyed, and the tougher *stratum corneum* is pushed up by a drop of pus to form a pustule or pock. Resolution may occur, or the surface breaks, and a small punctate area of granulation is left bare. This on healing leaves a cicatrix according to the size and depth of the pustule.

Cause.—Microbes lodging in the deep layers of the skin (gland ducts, hair follicles, cracks in the horny layer, etc.) normally inactive, but multiplying in presence of small wounds or inflammations, especially in the presence of heat and moisture. It may occur in course of small-pox, etc., but pyogenic microbes are found to be present.

Symptoms.—A minute area of suppuration is seen, with an areola of inflammation : it is often multiple.

Treatment.—Open the pustule by incision, or slicing off the top, to leave an open wound ; apply absorbent antiseptic dressing to prevent accumulation of pus and the spread of the pustule.

Purulent Catarrh. — Suppuration from the deep layers of the skin, similar in origin to the above, but involving a larger area, the cause being of the same nature.

Pathologically it is not different except that the signs are all more marked and the destruction of the skin more widespread.

Symptoms.—Burning sensation and stiffness ; tenderness, when the surface is rawed. Constitutional symptoms vary with the extent of the injury to the skin. Where the inflammation is confined to the superficial layers it often causes great pain on account of the many nerve-endings involved.

Treatment.—Absorbent, unirritating dressings, preferably dry, are applied ; moist dressings may be used if scabs form, to prevent the retention of pus ; the young granulations must be protected from injury. In the later stages of healing, when the epithelium is hardening, unguents may be used with the precautions that the part and the ointment are both aseptic.

ULCERATION.

Ulceration is suppuration involving the whole depth of the skin or mucous membrane, and penetrating to the subjacent layers.

Pathologically there is an area of suppuration, like the foregoing, originating in the same way, or formed by the failure of a wound or abscess to heal. The whole depth is infiltrated with pus cells, and degeneration of the tissue cells takes place (*molecular death*), with formation of small sloughs and effusion. The primary irritation tends to produce a reactionary formation of granulation tissue at the edges and base ; but if the irritation is intense, destruction progresses faster than the healing process, and in bad cases it may penetrate to the deepest layers of the body, laying bare a wide extent of bone or other structures. Healing and cicatrization take place as in other suppurations when the source of irritation is removed.

Cause. — Pyogenic microbes. Staphylococci are present always in the skin, and may become active when the skin is injured, or the resistance of its cells is lowered by any constitutional cause, such as :—

1. Poor living, bad hygiene, old age, ill health, especially anaemia.
2. Specific diseases—tuberculosis, syphilis, scurvy.
3. Local disturbance of the circulation, from congestion (esp. by varicose veins, and cicatrices from former injuries), diminished arterial supply (from atheroma, etc.), or pressure.
4. Damp and dirty condition of the skin.

Progress.—(*a*) **Healing** by granulations from the base of the ulcer, until they reach the level of the surrounding skin : subsequent contraction, with approximation of the edges. A layer of epithelium spreads over it from the edges, and if any patch of epithelium is left in the middle it also spreads outwards. The resultant scar consists of fibrous tissue and a thin layer of epithelium. This contains very few vessels, no nerves, hairs, or glands ; it is weak and easily broken down ; and liable to ulceration, eczema, keloid, epithelioma, and to itching and pain.

(*b*) **Extension** to deeper layers, involving important structures such as blood-vessels, leading to dangerous haemorrhage, or the intestinal walls, leading to peritonitis.

(*c*) **A stationary condition** without extension may be established, and a large amount of cicatrization may take place at the edges ; but healing does not progress, and all the new-formed cells die off at the surface and fall off as pus cells.

Varieties of Ulcers :—

Simple healing ulcer
Exuberant
Oedematous
Callous
Varicose
Irritable

Inflammatory
Sloughing
Phagedaenic

Specific—
Tubercular
Syphilitic
Venereal
Scorbutic
Malignant

Simple healing Ulcer. In this the edges are shelving and covered with a bluish epithelium. The base is covered with a level layer of healthy and clean red granulations, discharging a small amount of serum and a few pus cells. The surrounding skin is healthy, and the ulcer gets steadily smaller.

Treatment consists of rest and gentle pressure, with protection from irritation by bland aseptic dressings. If the discharge is slight, dry absorbent wool or gauze may be used; but if profuse, a scab is apt to form under that and retain the secretion, and thus arrest healing. In these cases several layers of lint or gauze, well wrung out of boracic acid solution, should be placed on the ulcer and covered with gutta-percha tissue. The dressing should be thick enough to absorb a considerable amount of discharge, and should be changed before it is saturated, or it will act like a scab. The new-formed epithelium may be covered with "protective," perforated to prevent the discharge being retained beneath it. When the ulcer is very large, it may be grafted, if possible with whole-skin grafts, to obviate subsequent contraction.

Exuberant Ulcer has healthy edges, but the granulations rise above the surface of the surrounding skin; the discharge is purulent, and the granulations are dark red and bleed easily. The cause is congestion, due mostly to excessive contraction at the edges causing pressure on the small veins.

Œdematous Ulcer has healthy edges, but the granulations are soft, flabby, and raised; discharge is sero-purulent and profuse. The cause is the same.

Treatment in both.—Uniform pressure, and astringents locally (copper sulphate, silver nitrate, zinc sulphate, etc.).

Callous.—Hard condition occurs in neglected and old ulcers, common in varicose ulcers of the leg. The edges are thickened, smooth and white, from long inflammatory cicatrization; they are hard and gristly, insensitive, and in shape, steep and abrupt. The base has few or no granulations, and discharges serum, blood, and little pus; and it shows little or no tendency to heal. The surrounding tissues are thickened, and the skin often leathery and deeply pigmented.

Treatment consists of softening of the edges with moist dressings; uniform pressure by Martin's bandage, strapping, etc.; incisions into edges, to allow freer circulation; stimulating dressings—antiseptic, but not too strong; or the ulcer may be completely excised, and the surface covered with skin grafts.

Varicose Ulcer is associated with varicose veins, and is common in the legs, especially when the small venules in the skin are involved. There is at first congestion, then exudation, and often eczema, and deeply penetrating ulceration. This leads to spread of the inflammatory process in the adjacent veins (phlebitis), and so it progresses. Inflammatory thickening increases the congestion, and cuts off arterial supply, thus adding to the weakening conditions, which are also intensified by any injury to the skin. The ulcer is liable to destroy the wall of a varicose vein, and lead to alarming hæmorrhage. The skin is dusky, congested, and often discoloured by brown stains, which are due to destruction of red blood cells and freeing of their pigment (cf. Syphilis). These ulcers, if neglected, are the most common origin of callous ulcers.

Treatment consists in disinfection of the ulcer by continued application of weak antiseptic dressings, frequently renewed before they are saturated with discharge, or of a continuous antiseptic bath; of application of oxygen, or exposure to filtered air; of firm pressure on the superficial veins above and below, with Martin's or other bandage; of operations on the affected veins to relieve congestive pressure, with careful precautions to prevent infection entering them; of strapping to keep the edges of the skin from dragging, and to favour the spread of epithelium, care being taken that no discharge is allowed to accumulate beneath it, by using a perforated strapping and very frequent changes.

Perforating Ulcer is an ulcer of the sole of the foot, associated with diseases of the nerve supplying the part.

Irritable Ulcer is a small ulcer with its nerve-endings exposed, causing great pain, and found usually at the edge of the anus, or over the malleolus, and occurring chiefly among neurotic women.

Treatment.—Cauterisation, or incisions round it, to cut the affected nerves.

Inflammatory Ulcer is where it becomes inflamed by further irritation, especially by retention of its discharge; or occurring in persons suffering from alcoholism and the like. The ulcer has all the signs of inflammation, and its discharge is increased and purulent. The edges break down and become undermined, and healing stops. The surrounding skin is inflamed, and great pain is felt.

Treatment.—Rest and elevation of the part; removal of the source of irritation by absorbent dressings or otherwise;

soothing applications, moist heat, etc.; later, astringents are used, and the ulcer treated as other ulcers.

Sloughing Ulcer is a further degree of the preceding, with more tendency to formation of sloughs. These, if not completely separated, should be snipped away.

Phagedænic Ulcer (not common nowadays, but met with chiefly in venereal ulcerations), a rapidly spreading ulcer, with formation of wide sloughs and penetration to the cellular tissue. The floor is grey and sodden, and often bloody; the edges are eaten away, and the surrounding skin very inflamed. Constitutional signs are usually severe (*vide* Venereal Ulcer, Hospital Gangrene, etc.)

Treatment.—Painless and antiseptic cautery with pure carbolic acid, which is neutralised afterwards with alcohol; continuous antiseptic baths, or frequent renewal of antiseptic dressings; free incisions where there is cellulitis; amputation of a limb if necessary; constitutional—iron, and antistreptococcic serum when the ulcer is due to a streptococcus, should be administered.

The *specific* ulcers.

Tubercular Ulcer, usually of the œdematous type. It occurs in tuberculosis affecting any surface, and shows a tendency to heal, but to break down again, sometimes healing on one side, and spreading on the other. The edges are healthy; or in spreading conditions, the skin is often greatly thinned, dusky in colour, and deeply undermined. The floor is pale, the granulations are œdematous, and there are sometimes sloughs in the middle from poor blood-supply. Where there is much discharge, as at the mouth of a sinus, the granulations are very large and flabby (*vide* Tuberculosis, Lupus, etc.).

Pathology. —It is due to formation of tubercles, originating in the skin, with subsequent ulceration, or from tubercular masses breaking down and leaving an unhealed "tubercular sinus."

Treatment.—Excision of the ulcer wherever possible, followed if necessary by skin grafting; where impossible, thorough scraping, followed by cautery with carbolic acid or heat; application of iodoform and antiseptic dressings. Sunlight, Finsen-light, X-rays, high frequency currents, radium-rays are all expensive, and unsuitable except in superficial lupus. Tuberculin (R) produces a local reaction which helps healing. Though tubercular ulcers are often very curable, recurrences are also common.

Syphilitic Ulcers occur in secondary syphilis from involvement of the skin in the disease, and more commonly in tertiary, from breaking down of a gumma (*vide* Syphilis).

When the ulcer is superficial, the edges are "punched out"; the base is covered with sloughs or scabs, and the surrounding skin is red. In shape it is circular, and being multiple, the tendency is to coalesce and form irregular patterns (*serpiginous* ulcer), and it tends to heal at one side and spread on the other. When due to breaking down of a gumma the ulcer is deep and of any shape. The base is covered with greyish, broken-down gummatous tissue. The edges are clean-cut or undermined. The surrounding skin is often brown in patches.

Treatment.—Antiseptic dressings, removal of sloughs, and antisyphilitic treatment.

Chancroid (venereal) ulcer, occurs from non-syphilitic infection of the genitals. It may become phagedænic. There is usually a profuse discharge of pus and enlargement of the inguinal glands (*bubo*).

Scorbutic occurs in scurvy. The granulations are large, dusky, and bleed freely; the base often foul.

Treatment.—That of ordinary ulcers, and antiscorbutic measures.

Rodent Ulcers and other **malignant ulcers** (*vide* under Tumours).

Skin Grafting.—(*a*) **Reverdin's** method, for small ulcers. A small piece of epithelium is snipped off a purified part of the skin, and cut into bits the size of a pin's head. The ulcer is made as aseptic and healthy as possible, by previous dressing, and rubbed to make it raw, with pressure applied afterwards to stop all bleeding. The small pieces are then planted on the surface, base downwards. A layer of sterilised "protective," well perforated to drain off discharge, is applied, and covered with absorbent gauze firmly bandaged in place. In five days the grafts should be growing visibly, and each graft may be expected to cover ultimately an area the size of a sixpence. At the same time this stimulates the spread of epithelium from the edges. Any antiseptic used to prepare the parts or instruments must be thoroughly rinsed off with sterile saline solution, as contact with the grafts leads to their destruction.

(*b*) **Thiersch's** grafts for larger ulcers. Thin layers of epidermis are sliced off the thigh or arm, large enough to cover the ulcer completely. The razor is kept wet with saline solution to prevent the grafts from curling, and the skin may be kept level by pressing on it with a flat instrument. The surface of the ulcer is prepared as in the former method, and the layers of epidermis are spread over the whole area, overlapping the edges and each adjacent piece. The whole layer takes root if it is in contact with freshened granulations and if the parts are aseptic. A similar dressing is applied and the same precautions are taken as in Reverdin's method. Contraction of the cicatrix is less than in the former way, but the scar is similar to an ordinary cicatrix. The part supplying the graft is dressed like a superficial burn.

(*c*) **Wolfe-Krause** method of whole skin grafts. A piece of healthy purified skin rather larger than the ulcer is dissected off along with its subcutaneous tissue. The under surface is dissected clean, removing especially all the fat. The base and edges of the ulcer are dissected or scraped away, the bleeding is stopped, and the graft is accurately adjusted. A few sutures are inserted, and the parts treated as a fresh wound. The graft is nourished by the fluid exudation until new blood-vessels penetrate from the edges. A whole skin graft contracts very little, and a true skin surface is obtained, sometimes of considerable size. A convenient place to furnish the graft is the chest wall over the ribs, where the tissues are lax : the wound is sutured, and heals readily.

(*d*) **Sliding grafts** are taken in a similar way from the skin adjacent to the ulcer, but leaving a pedicle attached, to ensure a vascular supply. The part left bare should be sutured if possible, or may be treated as a granulating wound.

(*e*) **Mucous membrane** may be used for grafting in a similar way : the membrane of lower animals being sometimes used, as for repair of the urethra, etc.

GANGRENE.

Gangrene is death of tangible portions of the tissues, but the term is usually applied to death of a limb.

Slough, a dead piece of tough, soft tissue, *e.g.* skin, tendon, etc.

Necrosis is a term often applied to dead bone in particular ;

a loose piece of dead bone in a cavity is called a **sequestrum** : if in the form of a surface scale, it is called an **exfoliation** ; **caries** is ulceration of spongy bone.

Cause of Gangrene.—In all cases it is due ultimately to stoppage of the circulation, arising from obstruction of arteries, veins, or both.

Predisposing causes are interference with the general circulation, from weak heart's action arising from old age, exhaustion, fatty degeneration, and other diseases of the heart, anæmia, diabetes, and Bright's disease.

Immediate Causes.—1. **Direct** injury from crushing of the limb or part ; from burns or scalds, and frost-bites ; from the action of acids and alkalis : from pressure, such as bed-sores, strangulation of intestines by hernia, bands, or twists, or of tumours, fractures, dislocations, of foreign bodies or cicatrices, of tight bandages, tourniquets, and badly fitted splints.

2. **Inflammatory obstruction** with thrombosis due to microbes of suppuration, erysipelas, carbuncle, phagedæna, noma, etc.

3. **Arterial** or **venous obstruction** from injury or disease of a main vessel, especially where there is a defective anastomosis, or from ligature, where the collateral circulation is not established quickly enough.

4. **Obstruction** of the **smaller arteries**, by arterio-sclerosis leading to thrombosis ; by arteritis obliterans : by spasm of arterioles from Raynaud's disease ; or from ergot, and from carbolic acid applications.

When the parts die slowly with evaporation of the fluids, **dry gangrene** occurs ; when rapidly, with the veins congested, **moist gangrene.** The process is the same in both, varying only in time and in the amount of decomposition.

Moist Gangrene.—In a limb dead of gangrene, when the fluids remain in the tissues, the usual signs appear as in a body after death : there is loss of pulsation, warmth, and sensation ; the colour becomes mottled, then stained red with exuded hæmoglobin, changing to purple and green ; the skin becomes soft, wet, and slimy, and the epidermis is separated from the corium ; decomposition begins, with breaking down and liquefying of the tissues, ultimately exposing the bone ; there is discharge of foul fluid with an offensive smell.

Dry Gangrene, when the process is gradual, with the blood cut off at the arterial side, the parts affected dry up as they die. The tissues are bloodless if cut into; the skin, at first white and greasy, turns brown, then black, and hard and dry, and the soft tissues become mummified.

The **line of demarcation** is a zone of inflammation which separates the dead part from the living; at first it is irregular, but later, when the process is established, it forms a definite line. This is followed by ulceration, the **line of separation,** which forms a sulcus between the two parts. The dead tissue, if still attached, by causing further irritation, may lead to the spread of inflammation upwards, and a second line of demarcation may be formed. The poisons formed by the decomposing tissues are absorbable, and may cause severe constitutional symptoms.

Symptoms are those of inflammation, with toxæmia from absorption. Locally, the limb is apparently dead or dying; there is severe pain in the part, probably due to ischæmia, shifting to the point of ulceration as the limb dies. When the line of demarcation is not yet defined, the living part may be distinguished from the dead by being tender, inflamed, and red, with temporary pitting on pressure, and sensitive on pricking. The dead part is cold and insensitive, pale and bloodless, and the skin dry and hardening, in dry gangrene; while in moist, the skin is reddish purple, darkening in colour, soft and flabby, and a permanent pit is left on pressure, and a foul brownish fluid exudes on cutting into the part: pulsation is absent in both.

General Treatment of Gangrene.—The primary object is to prevent sepsis and putrefaction. The surface of the gangrenous part must be disinfected as thoroughly as possible (*vide* Treatment of Wounds), and kept dry, to help evaporation; any collection of fluid is to be drained, and dry antiseptic dressing applied, to prevent infection from the atmosphere. A nourishing and stimulating diet is necessary, and in most cases opium for the severe pain.

In dry gangrene this may suffice for a long time; but in moist gangrene, to prevent absorption of toxins, it is necessary to amputate the limb as soon as the diagnosis is made. This is to be done well above the area of inflammation, to prevent infection of the flaps.

Varieties.

Traumatic Gangrene occurs after severe injuries, **directly** by destruction of the tissues, or **indirectly** by rupture of the vessels supplying the limb: and is of the moist variety. The part below the injury is cold and insensitive, and mortification as described above sets in.

Treatment.—When the vitality of the part is doubtful, the limb must be cleaned and disinfected as much as possible, and wrapped in a thick layer of dry aseptic wadding to keep it warm, and raised on a pillow to favour circulation. Any external obstruction to a vessel should be removed. Where the injury has caused much shock morphine and stimulants help to restore the general circulation. When gangrene is established amputation is usually required.

Decubitus, or pressure sore, is necrosis of the skin or other surface from pressure of the body on the bed, or of bed-clothes on bony eminences (*bed-sores*), of badly-fitted or ill-padded splints, or artificial limbs, of a wrongly-shaped tracheotomy tube or pessary.

The commonest seats of **bed-sores** are on the skin over the sacrum, the buttocks, iliac crests, scapular spines, the elbows and heels, the trochanters and knees.

The chief predisposing **cause** is moisture and heat, with decomposition of sweat or urine, leading to irritation and inflammation. It occurs in weak people, especially the paralysed.

Appearance.—The skin becomes reddened and œdematous, and a blister forms. The sore may extend slowly from one point (ulceration), but often a patch of skin dies (slough), and the process spreads rapidly.

Treatment.—Preventive; most bed-sores can be prevented by (*a*) avoiding *pressure*, by using water-beds or air-pillows, which, however, are apt to favour the retention of perspiration, unless an absorbent pad is placed between them and the patient; or by placing porous pads of wool, etc., under the soft parts, to relieve the weight, with ring-pads for the heels and elbows; by frequent changing of the patient's position, to alter the seat of pressure; and by (*b*) keeping the skin *clean and dry*; by preventing its being soiled with urine, fæces, or perspiration, by the use of the catheter, bed-pan, or other utensils to catch and remove all fluids excreted; or by the use of pads of wadding, wood-wool, or sawdust, frequently changed, and of fresh draw-sheets whenever damp (not saturated); and especially by careful washing and drying of the skin, and bathing it afterwards with spirit. Turpentine should be avoided for cleansing, as it is apt to raise blisters if left in contact for long. Boracic acid dusting powder should be freely used.

When a slough has formed all dead pieces must be removed, the sore cauterised with pure carbolic, then washed with alcohol, and dressed frequently.

Senile Gangrene (dry) occurs in elderly people, especially if weakened by alcoholism or constitutional diseases; it is more common in men. It is due to narrowing of arteries (the tibial especially) from arterio-sclerosis. Premonitory signs are common, from the diminished blood-supply,—cold feet, tingling, numbness, or shooting pains in the legs. A trivial injury sets up inflammation; the circulation is unable to respond, thrombosis ensues, and the inflamed part dies. This may proceed further, steadily or intermittently, the line of demarcation forming slowly from the feebleness of the circulation. The dead part meanwhile dries up, the skin becoming parchment-like, then darkening to brown and black, while the soft tissues shrivel. The line of separation is marked by an ulcer, discharging a little pus.

The chief **signs** are obvious death of the part, the extreme painfulness of the process, and the sclerosed condition of the arteries.

Treatment.—*Prophylactic*: keep the limb warm and well protected from slight injuries, when it is affected with arterio-sclerosis; help the general circulation.

When gangrene is established amputation is necessary above the point of obstruction, *i.e.* usually in the upper part of the tibial vessels; this point being often considerably above the obvious gangrene.

Raynaud's Disease occurs in young persons, and is due probably to disturbance of the vasomotor centres. It affects chiefly the fingers and toes. The attacks are influenced by exposure to cold, and by shock and anxiety. There is (*a*) local syncope, with blanching and numbness of the parts, or (*b*) local asphyxia, when they are livid and painful. The attacks may last a few minutes or some hours. Hæmoglobinuria is often seen a few hours after an attack, and scleroderma of the parts is not uncommon. Gangrene, when it appears, begins at the extremities, usually preceded by vesiculation on the skin.

Treatment.—Prophylactic, consists in avoiding cold, and in the use of nitrites; and local, in stimulating the part by massage or the interrupted primary electric current. Amputation is necessary when gangrene has set in.

Frost-bite causes gangrene (*a*) *directly*, by killing the tissues, or (*b*) *indirectly*, by excessive reactionary inflammation in the weakened tissues. It affects the fingers, toes, and ears chiefly, and is often met with among seamen.

The part becomes blue and painful, then pale, bloodless ("dead-looking"), and numb, and gangrene, usually of the dry variety, follows if this stage lasts long.

Treatment.—If the part is not yet dead, rub it well with ice or cold water to bring back the circulation very gradually, and do not expose it to warm air till the circulation is restored. Gangrenous parts must be amputated.

Carbolic Acid applied to the extremities, even in weak solutions, may cause gangrene in susceptible people, especially if an impermeable dressing is used. The skin becomes bloodless and dies, the necrosis spreading to the deeper tissues. Owing to the anæsthetic effect of carbolic acid the process is painless, and is not noticed till too late.

Phosphorus Necrosis is due primarily to the irritating vapour of phosphorus attacking decayed teeth. The necrosis spreads to the jaw. Several cases have been found to be tubercular, but the original cause seems to be the phosphorus irritation.

Cancrum Oris, or **Noma**, occurs in badly-nourished infants and children. It affects the cheek, or the vulva, and probably starts from a trivial injury. In the cheek a slough forms, quickly turning black and spreading rapidly. The mouth is very foul, the breath fœtid, and saliva dribbles from the lips. Constitutional symptoms of toxæmia are severe.

The **cause** is a specific microbe, with pyogenic microbes in addition.

The best **treatment** is excision with a thermo-cautery knife; failing that, excision with a bistoury, followed by an application of pure carbolic acid; with stimulating general treatment in addition. The disease has a large mortality.

Acute Infective Gangrene, known also as "**acute traumatic gangrene,**" occurs from soiling of wounds or abrasions with dirt, especially cultivated earth. It is due probably to several similar microbes, and is recognised as "hospital gangrene," "malignant œdema," etc.

The disease spreads very rapidly. The limb becomes cold and pale, then livid, swollen, and œdematous; crepitation, from formation of gas, is felt, and the skin and soft parts quickly die. Constitutional symptoms are very severe, and the disease is very fatal (twenty to thirty hours).

Treatment.—Amputation as soon as the disease is diagnosed, and reamputation if it still spreads. Every antiseptic precaution must be used to prevent the spread of infection from the diseased part.

CHAPTER II.

INFECTIVE DISEASES—BACTERIOLOGY—ANIMAL PARASITES.

INFECTIVE DISEASES.

Infective diseases are those which are due to the invasion of the body by micro-organisms of some sort, acting as parasites; the chief being **Bacteria**, or *schizomycetes* (fission-fungi), the lowest forms of vegetable life. The name bacteria is applied to all the schizomycetes; but the terms *micro-organisms*, *microbes*, or *germs*, though held to apply to the lowest animal organisms and some of the higher vegetable forms, are used in the same sense.

There are three divisions of bacteria:—

1. **Cocci** are small spherical bodies; if arranged in pairs they are called *diplococci*; in chains, *streptococci*; in fours, *tetrads*; in packets of eight, *sarcinæ*; in clumps, *staphylococci*.

2. **Bacilli** are straight rods, long or short (*micro-bacilli*). The word *bacterium* (a rod) is now used only to denote the whole group.

3. **Spirilla** are spiral rods (*vibrio*, a comma-shaped rod; *spirochæta*, wavy rod).

Structure.—Bacteria are composed of *protoplasm*, almost homogeneous, reacting to aniline dyes, surrounded by an *envelope* which may attain to considerable thickness (*capsule*). This may be furnished with *flagella*, which allow of free movement.

Reproduction takes place, in favourable circumstances, by direct division into two (sometimes in 20-30 minutes), and repeated until conditions are unsuitable for further division. When this occurs, division is sometimes irregular, giving rise to *involution forms*.

Spores are formed in some bacteria when the conditions, especially food-supply, are unsuitable for vegetative growth. They only occur in bacilli and spirilla, and appear near the ends or in the centre (*endospores*). They consist of masses of protoplasm with very dense cell-walls, and are non-motile: they are stained with difficulty, and only by certain methods; and they are very resistant to all germicidal agents.

Conditions of Growth.—Suitable food, always organic, with the presence of certain salts, is necessary; hence they do not grow in pure water, though they may live for long in it. Moisture must be present to a certain degree, or growth stops: hence the preservation of food by sugar and salt, and other dehydrating agents. Temperature: growth proceeds at the optimum temperature of 35°-39° C. for pathogenic microbes, 20°-24° C. for putrefactive; the limits being about 12°-45° C., though the organisms are not killed by these temperatures. Air is necessary to most (*aërobic*), but some grow best, or only, in the absence of oxygen (*facultative* and *obligatory anaërobic*). Light, especially direct sunlight, is inimical to all disease germs.

Antiseptics.—The presence of certain chemicals in the culture medium prevents growth without killing; such are boracic, salicylic, and the mineral acids, and weak solutions of germicides.

Germicides.—See **Disinfection.**

Habitat of Microbes.

1. Microbes are present in the **air,** usually attached to dust particles; where the dust settles, as on the ocean, or in a closed chamber, the air is left germ-free. Though microbes have no tendency to be blown from a fluid or a moist surface, they may be scattered from used dressings, from the drying edges of wounds, and from the lips and nose by sneezing, etc.

2. **Soil** usually contains enormous numbers, mostly non-pathogenic; but the bacillus of tetanus and malignant œdema are often present.

3. **Tap-water** practically always contains bacteria, but the number varies with the temperature, the purity (*i.e.* absence of food), effects of sunlight and contamination.

4. **Surfaces** on which microbes have fallen remain infected till they are purified. The surface of the skin and intestinal mucous membrane have both a number of microbes always living and flourishing on and in them.

Disinfection.—Most bacteria are killed by exposure to a **heat** of 57° C., if continued long enough. All bacteria and spores are killed by *dry heat* of 170° C. for 3½ hours; red heat kills instantly, otherwise *moist heat* kills more rapidly than dry.

Cocci and growing bacilli are killed by *boiling water* in 5 minutes, and all spores in 1½ hours. (1 per cent sodium carbonate added to the water raises the boiling point to 104° C., and also partly dissolves the microbes.)

Steam at 100° C. kills cocci and growing bacilli in 15-20 minutes, and all spores in 1½ hours. *Steam under pressure* (of 23 lbs. at a temperature of 115° C.) kills all spores in 15 minutes.

Cold, even in the most extreme degree, does not usually kill bacteria.

Sunlight, and some forms of *electricity*, kill bacteria, and probably do so to a great extent in nature.

Chemical Disinfection.—*Germicides.*—These must be distinguished clearly from antiseptics, which only inhibit growth. If an antiseptic is removed by washing, filtration, dilution, or neutralisation by chemical means, the bacteria as a rule grow freely again; while no growth will take place if the substance is a true germicide. If the microbes are *mixed* with pus, fat, dried blood, or epithelial scales, the chemical may never reach them, or only after a long time. Spores are very resistant to chemical as to other germicidal agents (for instance, sublimate 1-1000 kills bacteria in 1 minute, but spores only in 30 hours), and various bacteria are more susceptible, or the reverse, to certain chemicals than others.

Germicides must be in *solution*, watery for preference (solutions in alcohol and glycerine are much weaker; those in oil or collodion are practically inert); they must be allowed to act for a certain *time*, and be in sufficient *proportion* to the matter to be disinfected, and must not be rendered inert by chemical action.

Modes of Bacterial Action.

Distribution in the body. They may remain at the place of entrance and cause *local reaction* (*e.g.* suppuration), or *general reaction* (*e.g.* tetanus), or pass by the blood stream to form *lesions in other organs* (*e.g.* tubercle).

Production of Poisons.—Pathogenic organisms act by producing **toxins**, complex bodies, whose nature is not yet definite: these cause local changes and general "toxic" symptoms.

(A) The *local changes* are first *degenerative*, from direct injury of the toxins; followed by *reparative* or defensive reaction on the part of the leucocytes and fixed cells, which, if not overpowered by the poison, have the property of engulfing and destroying the bacteria (*phagocytes*). These are guided to the focus of infection by *chemiotaxis*, and appear in numbers in the blood (*leucocytosis*). This results in a local functional activity and increased cell growth.

(B) In addition, certain *general lesions* occur from the circulation in the blood of the toxins alone. Of these the chief are (*a*) cloudy swelling, and even necrosis of gland cells, especially of the liver and kidney; (*b*) degeneration of arterioles, sometimes accompanied by hæmorrhages; (*c*) eruptions in the skin; and (*d*) degenerations in the nervous system.

(C) *Disturbance of metabolism* also occur; (*a*) general malnutrition and cachexia; (*b*) functional disturbance of secreting glands; (*c*) fever; and (*d*) disorders of the central nervous system.

Immunity against bacteria or their toxins is either natural or acquired. Toxins, in addition to the effects above noted, have the power, in cases where they are not fatal, of stimulating the body cells to form an *antitoxin*, which neutralises the poison, and *opsonin*, which probably allows the phagocytes to act. The antitoxin formation continues for some time after the disease is ended, and will prevent a reinfection by the same microbe. This property has been utilised to confer *artificial immunity* in man, by injecting the blood serum of a highly immunised animal, containing a large amount of antitoxin (as in diphtheria); other similar sera are used which have an *antibacterial* property (antistreptococcic serum). The two properties are not necessarily found in the same serum.

VARIETIES OF BACTERIA.

Staphylococcus pyogenes aureus, spherical; with diameter of ·9 μ, growing in clusters like a "bunch of grapes"; grows rapidly on most nutrient media, forming a golden layer on agar, and liquefies gelatine; found in *acute suppuration*, *abscess*, *osteomyelitis*, *pustules*, *boils*, and *pyæmic abscesses*, and along with others in *ischio-rectal abscess*, *appendicitis*, *gonorrhœa*, etc.

Staphylococcus pyogenes albus, with the same appearance under the microscope, but growing with a white colour; less virulent than aureus; found in *abscess* and other *suppurations*.

Staphylococcus pyogenes citreus, with a lemon yellow colour, found in abscess, but usually along with some others.

Staphylococcus epidermidis albus, a very common inhabitant of the skin, but less virulent than the others; found, however, in *stitch abscesses*.

Staphylococcus cereus flavus and **cereus albus**, (waxy yellow and white), occur less commonly.

Streptococcus pyogenes, growing in chains, like a "string of beads"; white in colour, not liquefying gelatine, of rather slower growth than staphylococci; found in *cellulitis*, *abscesses*, *ulcerative endocarditis*, *peritonitis*, *empyema*, *puerperal infection*, and *acute osteomyelitis*.

Streptococcus erysipelatis, similar in appearance to the last, and probably only a certain strain of the same, but giving rise to *erysipelas* instead of suppuration.

Diplococcus gonorrhœa, or **gonococcus**, two cocci in contact, with the adjacent sides flattened, growing in the body in clumps, and often seen occupying the greater part of a leucocyte. Very hard to cultivate.

Diplococcus pneumoniæ, or **pneumoccus**, a double coccus, surrounded by a capsule, found in *pneumonia* (most cases), and in pus of *pleuritic effusions*, etc.

Pneumo-bacillus, a short capsulated rod, occurring in about 5 per cent of *pneumonias*.

Bacillus pyocyaneus, giving a blue or green colour to pus, and capable of setting up septicæmia in rabbits, but probably non-pyogenic in man. Found sometimes in *cerebral abscesses*, and in *sinuses* of long standing.

Bacillus coli communis, constantly present in the *intestinal tract* of man and the higher animals. Found also in suppurative *peritonitis*, where there is any communication between the bowel and the peritoneal cavity: also in *pancreatitis*, *pyelitis*, *cystitis*, in the fluid of a *strangulated hernia*, and round about the *anus*.

Bacillus typhi abdominis (enteric fever), very similar in appearance and growth to the foregoing, and difficult to distinguish: it causes, surgically, *ulceration of bowel*, *abscesses* in glandular organs and bone, *synovitis* and *phlebitis*; in these cases usually found mixed with others.

Bacillus anthracis, found in "malignant pustule," "wool-sorters' disease," and "splenic fever." A large rod (6-8 μ long), growing rapidly on most media, and forming very resistant *spores*.

Bacillus diphtheriæ, found in false membrane and mouth, sometimes long after an attack of the disease.

Bacillus mallei, the microbe of glanders or farcy.

Bacillus tuberculosis. Resistant to all germicidal agents, difficult to cultivate, and requiring special methods of staining. Produces "tuberculin," used in lower animals for diagnostic purposes. Not a true pyogenic microbe. Probably forms *spores*.

Bacillus lepræ, the microbe found in leprosy, similar in appearance and staining properties to bacillus tuberculosis.

Bacillus tetani, found in wounds causing tetanus. A common inhabitant of cultivated earth and stable manure. Grows best in *absence of air*. Forms *spores* very resistant to all germicidal agents: (these are very characteristic, the so-called "drum sticks," from the spores forming a club at one end).

Bacillus œdematis maligni (*Vibrion septique*), found in acute spreading infective) gangrene: forms very resistant spores, and like bacillus tetani, is *anaërobic*, and is found in earth and mud. Not very common in wounds nowadays.

Bacillus of chancroid (soft sore), Ducrey's bacillus, a small rod, often in chains. Not yet grown outside the body.

Actinomyces (ray fungus), a streptothrix, 0·5 μ thick, and very long; it grows, in animals, in yellowish or greenish clumps.

General Infective Processes.

Sepsis (from σήπειν, to mortify), is generally applied to pyogenic infections; it includes:—

(*a*) *Toxæmia* (septic intoxication).
(*b*) *Septicæmia.*
(*c*) *Pyæmia.*

(*a*) **Toxæmia**, or **septic intoxication**, is the condition set up by absorption of toxins, the poisonous products of bacterial growth. When due to putrefaction of dead tissues, it may be spoken of as *sapræmia*, but the distinction is often difficult, and of little practical importance.

The poison is produced by the microbes at one spot, and its effects are proportionate to the amount produced and absorbed; the blood remains free from microbes.

It occurs from infection of an operative, or more commonly an accidental wound; from an abscess or empyema; from putrefaction of sloughing tissues; from blocking of a sinus or abscess opening, and retention of the pus; from infection of an ulcer or tubercular surface by putrefactive or other microbes.

When absorption takes place, the following effects are produced:—

1. **Septic Traumatic Fever.**—The symptoms begin as a rule two days after infection, and generally with a rigor. The temperature rises rapidly to 102° to 104° F., with remissions each morning to nearly normal. The pulse is bounding and rapid, the tongue furred, the bowels are constipated, and appetite is lost; the skin is dry and hot, the urine high-coloured and scanty; there is headache, and sometimes delirium, and leucocytosis occur in most cases.

These symptoms continue as long as absorption goes on, but disappear as soon as it is stopped. This implies drainage of discharges, opening of abscesses, breaking down of septa, emptying pockets of pus, removal of sloughs, and amputation of gangrenous limbs.

If relief is not given the patient may die of coma, or the condition may become chronic.

2. **Hectic Fever** is the chronic form arising from partial retention of discharges, or from septic infection of wide surfaces, such as a tubercular cavity.

Symptoms.—There is fever in the evenings, 101° to 103° F. with morning remissions, the cheeks are flushed and thin, the eyes bright and sunken, the tongue is red and dry, and the appetite poor; diarrhœa is common, and the urine is loaded with urates; profuse sweating occurs at night, the patient wastes, and bed-sores are apt to be formed.

Treatment.—Locally, any focus of absorption must be removed; constitutionally, stimulating and nourishing diet are essential. Tonics, acids, and atropine may be given to subdue the perspiration.

3. **Amyloid Disease** is apt to ensue, with or without hectic fever, where there is a long-continued discharge. It affects chiefly the liver, kidneys, spleen, and intestines, and leads to a degeneration, causing swelling of the tissue and loss of function. The symptoms are albuminuria, diarrhœa, and enlargement of the liver and spleen.

Treatment.—Removal of the cause, and generous nourishment.

(*b*) **Septicæmia.**—The microbes may spread from the primary focus, either through the lymphatic vessels and glands, and thus form fresh foci of infection, or they may spread into the blood stream through an eroded vessel, when they may

1. Be *killed* by the bactericidal power of the blood.
2. Be carried as an *embolus*, and blocked in one of the finer vessels, and set up a new focus (*vide* Pyæmia).
3. Find the blood impoverished, and *flourish* in it (true Septicæmia).

Clinically, it is hard to draw a line between Toxæmia and Septicæmia, owing to the difficulty of recognising the presence of microbes in human blood in pyogenic infections.

The **symptoms** are more severe, the temperature rising to 103° to 104° F., with little remission except before death; the pulse is more feeble and rapid (up to 130), the tongue is furred and brown, becoming dry and cracked, and the mouth is covered with sordes; there is constipation at first, followed afterwards by diarrhœa, the appetite is lost, there is nausea, and occasional dark-coloured vomit; the skin is dry and hot, becoming later moist and clammy, often with mottling and duskiness; the face is pinched and earthy in colour; there is usually delirium, stupor, and headache.

Treatment consists in removal of any **local** source of infection, by flushing, drainage, curetting, amputation of dead parts, and artificial congestion by warmth and constriction.

General treatment consists of all means to favour elimination of poisons, nourishing diet, free stimulation, and in streptococcic infections the free use of antistreptococcic serum.

(*c*) **Pyæmia** is the condition when secondary foci (*metastatic abscesses*) are formed by the deposit of microbes in one of the small vessels. A thrombus forms and becomes purulent, and it may itself form secondary abscesses.

When the primary lesion is in the systemic system, the metastatic deposits are found mainly in the lungs, and *vice versa*; if in the portal system, the secondary deposits are usually in the liver; but infection may be carried from any part of the body to any other.

Cause.—It may follow on any septic process—wounds, compound fractures, puerperal infections, abscesses, etc. The source may be undiscovered, when it is called *cryptogenetic* (formerly *idiopathic*). It is usually associated with the staphylococcus pyogenes, but other microbes may be present, especially streptococcus or bacillus coli.

Symptoms are those of septicæmia, with prolonged rigors occurring at the formation of each new abscess. The temperature is high, but with deeper depressions, usually accompanied by profuse sweating. The pulse, which becomes more rapid, falls in rate along with the temperature, and is weak and soft. The breath and skin have a faint sweet odour. Diarrhœa and delirium are common.

Metastatic Abscesses develop, usually without pain, under the skin and in the deeper tissues, where they can be felt or seen; in the joints, with pain and stiffness, swelling and fluctuation; in the lungs, giving rise to cough and spit and dulness, and sometimes pleuritic friction; in the liver, with swelling, tenderness, and sometimes jaundice; and elsewhere, with interference of the function of the affected part.

Prognosis is very grave.

Treatment is the same as for septicæmia, with the addition, that every abscess should be treated as soon as it forms, if it is accessible.

SPECIAL INFECTIONS.

Staphylococcus pyogenes gives rise to suppurations of various kinds (see **Suppuration**, and disease of special tissues).

Streptococcus pyogenes and **erysipelatis** give rise to erysipelas when infection comes from a case of erysipelas, and to cellulitis when it comes from other sources—the effects depending on the virulence of the microbe. There is no sharp border line between the two, and the intermediate condition of cellulo-cutaneous erysipelas is common. A distinct connection can often be traced between *puerperal* infection and *erysipelas.*

Cutaneous erysipelas is an inflammation of the skin (*infective dermatitis*) starting from a wound or scratch, or cryptogenetic, without visible origin.

Cause.—*Predisposing*; infancy and old age; bad air and overcrowding; malnutrition, wasting diseases, previous attacks; Bright's disease and diabetes; exposure to cold. Locally, dirty and irritable skin. *Exciting*; infection through the skin.

Pathology.—Streptococci are found in large numbers in the lymphatics of the cutis and underlying tissues, just beyond the swollen margin of the inflammatory area. As the inflammation advances they gradually die out, and after a time this extension at the periphery comes to an end. In the course of inflammation they cause exudation between the epithelial cells, while leucocytes collect, the fixed cells degenerate, and vesicles are often formed. The lymphatic vessels and glands become inflamed.

Symptoms.—The skin is hot to the touch and very red, the colour disappearing on pressure, but returning at once when that is relieved; the limits of the redness are generally abrupt; there is œdema and swelling, causing stiffness in moving the joints, and puffiness about the loose parts (eyelids, scrotum, etc.), and glazing of the skin from distension; vesicles usually appear on the surface, and desquamation occurs as the disease subsides. If there is a wound it stops healing and looks unhealthy. The lymphatic vessels may be outlined in red (*lymphangitis*), and the glands tender. There is intense burning pain and itching all over the affected part.

Constitutionally, there is chill or rigor, followed by fever 103°-105° F., which remains steady with little remission; rapid pulse and respiration, foul tongue, constipated bowels, poor appetite; albuminuria, usually transient; and often delirium.

Prognosis is good when there is no cellulitis.

Terminations.—After 7-14 days it usually subsides, the temperature falling rapidly, and the symptoms disappearing as it falls. Or it may wander to another region (*E. migrans*). It may spread to the larynx, orbit, ear, bronchi, or lungs; it may set up meningitis, peritonitis, or pneumonitis, or it may go on to cellulo-cutaneous erysipelas.

Treatment.—Purge the bowels; restrict the patient to slop diet; iron tonics, and in bad cases, antistreptococcic serum (10 c.c. repeated at intervals of 5-6 hours for 4 doses) are useful. *Locally*, treat the part with cooling lotions, ointments, and powders, and especially preparations of ichthyol, to allay the extreme itching and pain; with cutaneous irritation beyond the margins of inflammation to produce an artificial congestion, and so increase the local immunity, by means of scarifying, applications of iron salts, silver nitrate, iodine tincture, or by elastic constriction.

Cellulo-cutaneous erysipelas occurs when the infection invades the cellular tissue beneath the skin as well. It usually goes on to suppuration and sloughing of the skin. It occurs more often after wounds.

Pathology.—The lymph spaces are filled with leucocytes, and the connective-tissue cells liquefy. The separate spaces coalesce, and infection spreads along the planes of least resistance; it does not usually spread beneath the deep fascia.

Symptoms: like erysipelas, but more severe. Swelling is greater, and becomes boggy as suppuration occurs. Redness is less marked and defined, but the skin is often dark and marbled; bullæ form from fusing of the vesicles; pain, at first burning, becomes dull and throbbing as pus forms.

Constitutionally, the temperature is high, but shows more remissions; delirium and insomnia are common; "typhoid" conditions are apt to appear.

Prognosis.—Less favourable the more the cellulitis predominates.

Treatment.—Incisions should be made freely as soon as pus is diagnosed, and all septa broken down to allow free drainage to all discharge; sloughs must be removed; moist antiseptic dressings frequently changed are applied, or the limb may be kept in a continuous antiseptic bath; artificial congestion may be of use.

General: when suppuration occurs diet must be sustaining; stimulants and opium are generally required. Antistreptococcic serum in repeated doses.

Terminations.—Repair usually takes place; but fatal septicæmia, broncho-pneumonia, or hectic fever may ensue, or it may go on to cellulitis.

Cellulitis (*cellular erysipelas*) is infection of the deeper layers,—subcutaneous, intermuscular, etc.,—with streptococcus, usually mixed with staphylococcus, and sometimes with putrefactive organisms. It occurs with septic wounds or along with erysipelas, and there is a greater tendency to spread of the infection, sloughing of the skin, and death from septicæmia. The glands may be involved and become secondary foci of infection.

Symptoms, etc. (*vide* p. 7).—Treatment as in the foregoing.

Special forms of cellulitis occur in (*a*) the deep fascia of the neck (*Angina Ludovici*); (*b*) the *pelvic* fascia following parturition and pelvic operations; (*c*) in the *perineum*, *penis*, *scrotum*, and *abdomen*, from putrid decomposition of extravasated urine; (*d*) in the *axilla*, from poisoned wounds of the hand.

Soft Chancre (*chancroid*) is a non-syphilitic sore on the genitals, arising from infection of the same kind during coitus.

Cause.—Ducrey's bacillus.

Symptoms.—After an incubation period of 2-5 days pustules form, and ulceration rapidly ensues. The ulcers are usually multiple, and surrounded with an area of inflammation. The edges are undercut, and the base is yellowish grey, discharging a quantity of pus. They are usually situated on the corona glandis or the prepuce, or on the labia, but they may inoculate the skin of the thigh or groin. The inguinal lymphatics are usually implicated, and the glands become swollen and tender, and often suppurate (*soft bubo*). The constitutional effects are comparatively trivial.

Diagnosis (see Syphilis).

Prognosis.—If treated, they disappear in three weeks or so; if not, they may give rise to *phagedæna*.

Treatment.—Expose the sore, cleanse it, and treat it with antiseptic lotions, powders, or moist dressings. If a phimosis conceal it the discharge is apt to collect, and the foreskin must then be split up.

If the glands inflame the patient should be kept in bed; when suppuration occurs, an incision should be made early in the line of Poupart's ligament. If a sinus is left it should be laid open and scraped, and allowed to heal from the bottom.

Phagedæna is apt to ensue in ill-nourished subjects suffering from neglected chancres, especially those concealed under a long foreskin. It spreads rapidly, with sloughing of the skin and soft parts. This may occur in either syphilitic or non-syphilitic sores, and is probably due to a further infection of virulent pyogenic or putrefactive organisms. Bleeding from the ulcers is apt to follow from opening up of vessels; and the discharge is profuse and foul-smelling.

Treatment (*vide* p. 17).

GONORRHŒA.

Gonorrhœa is a specific inflammation set up by the gonococcus, usually affecting the urethra in the male, the urethra and vagina in the female, the vulva in little girls, and the conjunctiva, especially in infants.

Cause.—Infection takes place in the adult during coitus, as a rule; while it is conveyed to the eyes by the fingers, towels, etc., and in infants during the process of birth. In little girls vulvo-vaginitis, which is usually gonorrhœal, may be produced by infected bed-clothes, etc.

Pathology.—The microbes are implanted in the urinary meatus by simple contact, and set up a muco-purulent catarrh. They are found free in the pus, and in clumps occupying the superficial epithelial cells and the leucocytes. They penetrate to the deep layers of the mucous membrane, especially in the posterior part of the urethra, where they may reach the submucous layer. The inflammation spreads backwards, and may reach the prostate and beyond it. It causes a desquamation of the epithelial cells, and often a submucous inflammation (*peri-urethritis*).

Symptoms.—1. *Incubation Stage*—3-5 days after infection, itching and burning at the end of the penis, and stickiness of the lips of the meatus.

2. *Acute Stage.*—Swelling of the mucous membrane, with divided stream of urine; thick pus (with characteristic appear-

ance under the microscope), pain on micturition, often referred to the groin or perineum ; swelling of the corpus spongiosum, and often œdema of the prepuce ; sometimes inflammatory abrasions of the glans ; cordee (painful erections, with twisting of the penis from inflammatory thickenings) ; retention of urine from spasm of the sphincter.

3. *Decline.*—After 2-4 weeks the discharge becomes more serous, and the pain and other symptoms abate. It may, however, become chronic (*gleet*).

Complications.—Spread of infection (*a*) by continuity,—balanitis, and inflammation of the prepuce, sometimes causing paraphimosis (*i.e.* constriction from swelling behind the glans) ; infections of Cowper's glands, prostate, vesiculi seminales, vasa deferentia, and epididymes, or of bladder, ureters, and kidney (rare) ; (*b*) through the submucous tissue, the lacunæ, and the lymphatics, setting up abscesses or stricture, and lymphadenitis (buboes), or septicæmia ("gonorrhœal rheumatism"), with local manifestations in various parts. In the female it may spread as in the male to the urinary organs ; and also to Bartholin's glands, and commonly to the uterus and Fallopian tubes, setting up pelvic peritonitis or pelvic cellulitis. Gonorrhœal ophthalmia (rarely spreading to the nose) is common among children.

For **diagnosis** and **treatment** see diseases of regions.

SYPHILIS.

Syphilis is a constitutional disease, with local manifestations, produced by infections of a yet unknown kind, most commonly by *venereal* contact, but transmitted also by *inheritance.*

Cause.—Probably a bacillus or spirochaeta. Inoculation takes place through small abrasions, or the unbroken epithelium if not too thick. The disease is contagious only in the earlier stages—the tertiary lesions being probably non-infections. The virus is present in the blood, the fluid of mucous tubercles, and the secretions, such as the sperm, and probably the saliva, etc.

Immunity.—A person once infected never, or very rarely, becomes infected a second time ; a non-syphilitic mother bearing a syphilitic child is not infected from *that child* in suckling or otherwise (*Colles' law*). No animals but man (and possibly the higher apes) are inoculable. There is, of course, no mutual protection from hard and soft chancre.

The disease is divided into three indistinct phases—early or primary, secondary, and late or tertiary.

Primary lesion consists of a papule, the *chancre*, appearing about 24 days (the limits being 10-42) after inoculation. It consists of a mass of granulation tissue, inflammatory in nature, but rich in cells, which do not tend to break down into pus, but rather to form a scar on subsiding. The epithelial layer is usually but not always destroyed. The virus spreads to the nearest lymphatic glands, producing an inflammatory induration (*hard bubo*).

Secondary lesions appear after another incubation period of about 6-12 weeks (8-150 days); they are usually symmetrical and inflammatory, with or without eruptions on the skin or mucous membrane, or with hypertrophy of the papillæ (*condylomata* and *mucous tubercles*); there are probably also internal inflammations.

Tertiary lesions appear after a variable time, sometimes years. They consist for the most part of masses of granulation tissue (*gummata*), with a tendency to caseate in the middle and excite great new formation of connective tissue around them. The peripheral part consists of innumerable round cells, mixed with fibrous tissue, and the central part of shrunken cells and nuclei and fine fat granules. They form in any part of the body, and the *arteries* in the neighbourhood take part in the inflammation, the inner coat especially being affected, leading to narrowing and sometimes obliteration of the lumen. Hence *necrosis* is apt to occur, and ulceration when the gumma is near the surface. *Amyloid* disease is often associated with syphilis.

Symptoms.—The chancre usually occurs on the penis at the angle between the corona and prepuce, and is single or sometimes multiple. It consists of a round painless elevation, discharging a little clear serous fluid, or none, and the base is cartilaginous to the touch. The lymphatic vessels and glands are rapidly enlarged, and have the same "bullety" feeling, the vessels standing out as thin hard cords. The glands affected are the oblique inguinal set, lying along Poupart's ligament.

If *soft* chancre be present in addition, the discharge is profuse, and the glands are soft and tender; but when that is cured, the hardness remains both in the chancre and bubo after all the irritation has ceased. *Phagedæna* may occur along with a syphilitic sore.

Chancres may occur in other parts—*inside the meatus* in the male, and out of sight; in the female, usually on the *labia*, the *fourchette*, or the *cervix* uteri, rarely on the vaginal wall, on the skin of the *groin*, or the *anus*.

In *non-venereal* cases any part of the body may be the site of inoculation, but especially the lips, from infected pipes, spoons, etc.; the nipple, from suckling an infected child; the fingers of midwives and surgeons from contact with infected mucous membranes. The nearest corresponding glands become enlarged. In soft parts the induration may be so small that the chancre may resemble a carcinoma.

Diagnosis.—From *soft chancre*, by the absence of *pus* and the hardness and painlessness of the buboes (if both are present, the soft sore dries up under treatment, but leaves the indurated sore behind, with hard glands); from *epithelioma*, especially on the lips, by the history of rather rapid growth and its disappearance under mercurial treatment; from *excoriations* of the glans from gonorrhœal balanitis, by the effect of antiseptic treatment.

Treatment.—As removal of the chancre does not prevent general infection, mild antiseptic dressing is best—iodoform and boracic powder, with a pledget of wool to keep the adjacent surfaces from contact. Additional treatment with mercury should be commenced at once, as secondary symptoms may be prevented, though often only delayed if the mercury is given up.

Secondary lesions are the manifestations of the general infection of the body, and appear chiefly on the *skin*, *mucous membrane*, and the *lymphatic glands*. They begin in 6-12 weeks, and are distributed symmetrically. There is little constitutional disturbance as a rule, but sometimes slight fever and weakness. Headaches and pains in the bones, however, are common, especially at night, and there is often anæmia. The skin eruptions may resemble any of the non-syphilitic kinds, and often show more than one form in the body at the same time (*polymorphism*).

The first to appear is *roseola*, a red mottling on the chest and belly, fading on pressure, and along with it congestion of the mucous membrane of the mouth, palate, and pharynx, and often small ulcers of the tonsils. These give rise to no pain, and the patient is often unaware of their presence.

Maculæ (hyperæmia of the papillæ), with violet or brownish patches, intensified by cold, appear on the chest, abdomen, flexor surfaces of the arms and legs, and with it *alopecia* (loss of hair).

Papules on the trunk, limbs, and neck, forehead near the scalp, small, firm elevations, with scaly tops ("syphilitic *psoriasis*"), rarely giving rise to vesicles (*eczema*) or pustules (*impetigo*), but often with overgrowth of papillæ in moist situations, causing *warts* when these are free, and *condylomata* when they are fused together with swellings of the intervening tissue (very infectious). With these are associated *mucous tubercles* on the cheeks, tongue, gums, lips, anus, vulva, and prepuce (also very infectious). The *colour* in general of the eruptions is that of "*raw ham*" darkening to coppery brown.

The glands all over the body may become enlarged, especially those of the posterior cervical region.

In the female pregnancy is apt to end in abortion in the early months.

The other affections of this stage are *iritis* (after 4-7 months), *otitis media* and *interna*, often causing permanent deafness, *periostitis* and *synovitis*, with "rheumatic pains."

Progress.—In six months or so the lesions tend to disappear, but *late* symptoms are common at this time; they may occur after an interval, when they are spoken of as "reminders." The chief are—*leucoplakia*, white glazed patches on the sides of the tongue; *rupia*, papules which have ulcerated, and by spreading under a series of scabs form a crust like a limpet shell; *psoriasis* on the palms and soles, and red scaly areas on the scrotum.

Diagnosis.—The characteristics of syphilitic eruptions are—(1) symmetrical incidence; (2) polymorphous forms; (3) colour generally of "raw ham"; (4) position, appearing first on the abdomen, chest, front of arms, back of legs, palms and soles, sides and back of neck, face and brow, usually in that sequence, while the scaly eruptions avoid the tips of elbows and knees, as in true psoriasis: (5) the *shape* usually serpiginous. The swelling of the posterior *cervical glands*, apart from obvious irritation, is very characteristic.

Treatment consists of the continuous use of mercury by the mouth (blue pill, gr. 2, grey powder, gr. 2; or if these cause diarrhœa, mercuric chloride, gr. $\frac{1}{32}$), or by inunction of blue ointment under the axillæ or on the thighs (apt to cause irritation of the skin); by intramuscular injections of mercuric chloride, gr. $\frac{1}{8}$ (an accurate measure of the dose to be absorbed is possible). Intravenous injection and fumigation (sublimation) are of no particular advantage.

Mercurial treatment should be continued for two years, and need not be intermitted unless the patient loses weight or salivation is threatened. The waters of Aix-la-Chapelle and other spas are of use in helping the action of mercury without being themselves antisyphilitic. Fresh air, iron tonics for the anæmia, etc., are of great help.

Local.—Open sores are best dusted with calomel and zinc oxide. Ulcers in the mouth painted with 1-1000 mercuric chloride solution. *Thickenings* of bone are treated by giving potassium iodide in addition. **Marriage** should be forbidden for at least two years, and all symptoms should have disappeared before it is allowed.

The **tertiary stage** is again local, and the lesions are not symmetrical. Any tissue may be affected, and the process is a slow inflammatory infiltration (*gumma*). After reaching a certain size the tumour undergoes a fatty degeneration (caseation), and breaks down, often leaving an ulcer which does not heal till the mass has separated. The ulcers have a hard raised edge and indurated base, and have a tendency to become serpiginous (spreading at one side while healing at the other). In receding, they leave behind an area of sclerotic atrophy, or less commonly hypertrophy.

The chief local changes are:—

Chronic and relapsing periostitis leading to osseous nodes or hypertrophic sclerosis, or if neglected, to suppuration and necrosis.

Gummata in the substance of muscles, which often by their slow growth and absence of inflammation simulate tumours.

Gummata in liver, testes, lungs, and other viscera; in fibrous structures and cellular tissue; in the meninges of the brain and spinal cord; in capsules of joints, etc.

Diseases of the skin of a lupoid type, gummatous in commencement, and serpiginous in character.

Diseases of the tongue, chiefly hypertrophic sclerosis.

Aggressive structural disorders of the ganglionic, conductive, or central parts of the nervous system (sclerosis), with consequent functional results.

General tendency to tissue degeneration, such as amyloid disease.

Chronic inflammations of mucous membranes, with thickening or ulceration, leading to stenosis, as in the pharynx, rectum, etc.

Diagnosis of gummata from malignant *tumours*, by their history, and their disappearance under treatment; tertiary ulcers of the tongue, from *epitheliomata*, by their comparative painlessness, and in doubtful cases by microscopic examination; lupoid ulcers from lupus, by their intractable persistence under treatment.

Treatment.—*Potassium iodide* is the most useful drug to resolve gummatous tumours, without, however, having any direct effect on syphilitic poison. Hence in "late secondary" lesions mercury should be used also. Large doses do not give rise to any more harm than small ones, and are therefore to be preferred. If iodide *rashes* appear the sodium salt may be given instead, or the drug intermitted. The iodide should always be given freely diluted.

Hereditary syphilis may be transmitted from the father (*sperm* inheritance), or from the mother (*germ* inheritance), or from both.

At birth the child, as a rule, is quite healthy in appearance, and presents no local sore. After 3-6 weeks it suffers from coryza ("*snuffles*"), followed by skin eruptions. These begin as an *intertrigo* on the nates and genitals, developing into a papular or vesicular rash of a raw ham colour. Condylomata and mucous patches about the anus are common at this time. The child usually suffers from wasting and anæmia; it looks shrivelled and aged, the skin is earthy and dry, and the mouth and lips are affected with white ulcers (*stomatitis*). Affections of the ear (*otitis media* or *interna*), or eye (*iritis*, rare), or other organs may occur, or death ensue from exhaustion.

Under treatment the disease usually disappears within a year, and may remain away permanently. But lesions, tertiary in character, may reappear about puberty. These are—*interstitial keratitis*, with cloudy cornea, and ciliary congestion and irritability, tending to natural healing; *otitis media* and *interna*, with consequent deafness; if the disease is not treated, *ulceration of the palate*; *gummata of the viscera*.

Periostitis, with thickening at the epiphyses, and nodes on the cranial bones (*Parrot's nodes*), especially on the frontal and parietal eminences, producing the "hot-cross-bun" appearance; or with osteo-porosis; with arrest of growth from the epiphyses and irregular thinning of the skull bones (*cranio-tabes*); rarely with suppuration.

The **evidences** of early syphilis may be marked at this stage—imperfect development of the central incisor teeth from stomatitis, leaving the second teeth conical instead of square, and with a hollow at the point (*Hutchinson's teeth*). White lines radiating from the angles of the mouth, from ulcerations occurring at the same time. Sunken bridge of the nose, from ulceration or want of development of the nasal bones, consequent on the coryza. Dwarfing of the body. Osseous nodes on the long bones, and other evidences of periostitis.

The disease is not transmitted to a third generation, and has apparently no tendency to produce "scrofula," as at one time was thought.

Diagnosis in early stages from non-syphilitic rashes, by their persistence under ordinary treatment, and their clearing up rapidly under mercury; in later stages from rickets, by the aggregate of syphilitic signs.

Treatment.—In the early stages *mercury* should be given, grey powder (1 grain) by the mouth: or if that causes diarrhœa, by inunction of blue ointment (1 drachm), placed on the child's abdomen, and left to be rubbed in by the binder. It should be intermitted whenever the lesions disappear, and should never be pushed to salivation (mercurialism), lest the teeth be affected in their development, giving rise to transverse ridges and irregularities of the enamel at the margins.

Good food, fresh air, and cleanliness are essential.

TUBERCULOSIS.

Tuberculosis is an inflammatory process set up by the tubercle bacillus. The most abundant source of these microbes is from the dried sputum of phthisical patients.

They gain an entrance to the body by the respiratory tract: by the alimentary canal, including the mouth and throat; or by the skin. It is rarely transmitted direct by inheritance, though the predisposition to it is often hereditary.

Predisposing **causes** are bad food, bad hygiene, close air, damp and dark dwellings, want of exercise, overwork, exhaustion, previous illnesses, and especially hereditary tendency.

Local predisposing causes, inflammations, injuries, and cicatrices which all tend to lessen the immunity of the part.

Tubercular *diathesis* is common in children of two types: (*a*) The *sanguineous* type, where the child is soft and plump, with volatile spirits; the hair is fair and the skin fine; the cheeks are pink and translucent, and show the veins outlined in blue; the eyes are blue and often humid, and are fringed with long lashes; the upper lip is full and the finger ends are often clubbed: and (*b*) The *phlegmatic* type, where the child is fat and sluggish, with heavy features; the skin is hard and rough, and dark or muddy-looking; the lips are thick, the limbs wasted, the circulation is poor, and phlyctenular ophthalmia is common.

Pathology.—The tubercle consists essentially of a small nodule, the centre of which is usually a giant cell with several nuclei; around this is found a sphere of epithelioid cells lying in a fine reticulum. These cells are derived most likely from the endothelial cells of a capillary vessel in which the bacteria have lodged, and set up their specific stimulation. Surrounding this, and penetrating into the outer limits, is a mass of leucocytes. There are no vessels in the nodule, and the central part is liable to necrosis; and this readily takes place from the direct effect of the bacillary poison; calcareous infiltration often succeeds, especially in the more chronic conditions. Outside the tubercle is an area of inflammation, which in soft tissues gives rise to a considerable amount of œdema. Such small tubercules are seen in "miliary" tuberculosis, and larger tubercular masses are produced by the fusing of a number of small ones; the lining of a tubercular cavity (pyogenic membrane) is therefore a series of tubercules.

Progress.—The disease is chronic as a rule, and gives rise to various conditions. It may remain local and form a cold abscess; or become calcareous and encapsuled; or by pyogenic infection form an acute abscess; or it may spread by the lymphatics, involving the glands; or pass the glands, and by the blood stream produce lesions in joints, bones, serous membranes, or other parts; or general (miliary) tuberculosis.

Certain parts are more liable to tubercule;—the lungs especially; such serous membranes as the pleura, peritoneum, and cerebral meninges; the testicle, kidney, liver, spleen, and ovaries; the lower part of intestines; and the larynx. The bones are often affected, especially those parts composed of cancellous tissue; joints also (*white swelling*), lymphatic glands (*struma*), and the skin (*scrofula*, *lupus*), are common situations.

The chief **symptoms**, apart from the local lesions, are fever in the evening, and anæmia, with wasting and weakness.

Treatment, general: counteract in all ways the predisposing causes, especially by fresh air, day and night, if possible in the country or at the sea; abundant food, especially milk and fat; attention to the bowels; and sometimes iron, or cod-liver oil, if the body is thin. The local treatment will be spoken of in the later sections.

ACTINOMYCOSIS.

Actinomycosis is a chronic infective disease of the type of tuberculosis, caused by the *streptothrix actinomyces*. It is common in cattle, but affects man, appearing in the tongue or cheek as a tubercular mass, with diffuse induration and a tendency to suppurate. It affects also the jaws and other bones, causing an inflammatory necrosis. The pus from those lesions shows little yellow or grey granules (clumps of streptothrices), which are seen under the microscope to consist of a filamentous network; though the "ray" formation, with clubbed ends (involution form), is sometimes seen.

The disease is for the most part a local one, but is dangerous by forming a nidus for septic infection, or by involving important organs.

A generalised (*miliary*) form is also met with.

Prognosis, where the lesion is easily removed, is good; but less so when only medical measures are available.

Diagnosis from gummatous, tubercular, and cancerous tumours chiefly by microscopic examination.

Treatment.—Local masses should be excised, and abscesses drained. *Potassium iodide* in large doses (20-30 grs.) has a strong effect in counteracting the disease.

LEPROSY.

Leprosy is an infective disease set up by the *bacillus lepræ*.

Pathology.—The bacillus produces a nodule of very cellular inflammatory tissue, in and between which the bacilli are found in crowds. The lesions are formed usually beneath the skin (*cutaneous*), or around a nerve stem (*anæsthetic* form).

Symptoms.—After some prodromal signs of failing health, (*a*) a macular eruption appears, in the midst of which thickened masses are formed. These may attain great size, in the face giving rise to "*leontiasis*"; they usually ulcerate in the end, and involve the mouth, eyes, etc. Or (*b*) granulomata are deposited around a nerve trunk, leading to irritation, pain, etc., and subsequent paralysis and anæsthesia; while the parts supplied die off by gangrene.

Diagnosis is made from the presence of the bacilli.

Prognosis.—The disease is always fatal, but not immediately,—2-20 years.

Treatment.—Palliative; good food, etc., and surgical attention to any necrosed parts; prevention of sepsis.

Prevention.—Isolation of lepers, especially when there is any ulceration going on.

MADURA DISEASE.

Madura disease is somewhat similar to actinomycosis, and is produced by the *streptothrix maduræ*. It is confined to India.

Symptoms.—The bones of the feet, to which the disease is chiefly restricted, become necrosed, and the surrounding tissues are formed into a large shapeless mass of new-formed (inflammatory) connective tissue. This breaks down, forming abscesses and sinuses. The hand is sometimes affected.

Diagnosis from microscopical examination of the microbe.

Treatment.—Amputation. Iodides do not have any specific effect.

GLANDERS.

Glanders is an infective disease, caused by *bacillus mallei*, often epidemic amongst horses in an acute form (*glanders*), or in a chronic form (*farcy*). It is transmitted to stable workers, etc., by the discharges from the nose or from sores.

Pathology.—Small nodules of granulation tissue resembling tubercles are formed in the skin or mucous membrane; these soon suppurate and spread by the lymphatics. The mucous membrane of the naso-pharynx may be infected by the blood stream, and inflammatory ulcerations take place there. Powerful toxins are formed which produce symptoms of septicæmia.

Symptoms begin with fever, and redness and swelling at the point of inoculation, with lymphangitis spreading from it. Purulent catarrh of the nose, and later a rash like that of small-pox (papules, vesicles, pustules), become prominent. The lungs are involved (pneumonia), *or* the intestines (enteritis), with death following from heart failure.

In the *chronic* form the lymphatic glands are enlarged (*farcy buds*), and tend to suppurate and discharge.

Diagnosis from small-pox and other acute infections, and in the chronic form from tubercle and syphilis, by bacteriological examination of the discharge. (In animals by mallein injections.)

Prognosis, in acute form, bad (mortality 98 per cent), in chronic, better (50 per cent).

Treatment.—Opening of abscesses, scraping, and cauterising with carbolic acid. Isolation of the patient.

Preventive treatment in animals by detecting the disease with mallein and destroying infected beasts.

HYDROPHOBIA.

Hydrophobia, or **Rabies**, is an infective disease caused by a virus, as yet undiscovered, transmitted from rabid animals (rare in Britain).

Cause is usually the bite of a dog, but more rarely a cat. In foreign countries wolves are a common source of the disease. The virus exists in the saliva, and is introduced by any breach of the skin.

Pathology.—The virus, after an inoculation period, produces its poison, which acts on the medulla and brain, with subsequent loss of inhibitory power, when exaggerated reflexes of all kinds ensue. Sometimes there is congestion in the brain and cord, and small hæmorrhages, and in rarer cases paraplegia follows on the degeneration of nerve tissue.

Symptoms begin from fourteen days to six months or more, generally six weeks, after infection. The phase of *invasion* is characterised by restlessness, irritability, apprehension, and malaise. There is sighing respiration, loss of appetite, uneasiness in the epigastrium, and great thirst. The pulse is rapid and the respiration hurried; there is hyperaesthesia of the skin, and troubled dreams are common. There is generally some itching at the seat of the wound.

After two or three days the stage of *excitement* is established—the face is intensely anxious, apprehension gives way to terror, thick mucus collects in the throat, and leads to unavailing "hawking"; convulsions occur whenever the patient attempts to swallow liquid, though solids pass more easily, and even the sound or sight of water is sufficient to cause spasms. The convulsions are general over the body, and are tonic, or often intermittent (clonic). The intellect is variable, at times clear, at times showing suspicion or maniacal excitement. There is increasing hyperaesthesia, and sexual excitement with priapism. There is generally fever—the temperature rising to 100° to 103°.

Death occurs from asphyxia (spasm of respiration), or from syncope, or exhaustion, within ten days.

There is a rarer form of *paralytic* rabies, in which there is an ascending paraplegia, causing death when it reaches the respiratory muscles. (This is the usual form in rabbits used for the source of modified virus.)

Diagnosis, from tetanus, strychnine poisoning, and hysteria.

Prognosis.—Rabies once established is nearly always fatal; if treated before the symptoms appear by Pasteur's method the mortality is small; if before the sixth day about 0·2 per cent.

Treatment.—The bite must be cauterised, or excised, or it may safely be sucked if there is no abrasion of the mouth. Meanwhile the dog must be kept alive in a strong cage, to watch its subsequent career, if there is any doubt as to its madness; it will die rabid in a few days if it is affected. If the dog has been killed, its head and spinal cord should be packed in ice, and sent at once to a competent veterinary establishment for a report.

The patient should be sent at once to the nearest Pasteur institute for treatment. This consists of a series of injections of increasingly strong modified virus, each injection protects against the next, till an otherwise fatal dose has been injected, the incubation period of "accidental" rabies allowing of this process to be carried out.

Preventive measures consist of destruction of all rabid animals; registration or muzzling of all dogs; with quarantine of those imported dogs; and no stray dogs should be allowed at large. If these measures are confined to dogs the disease will die out. (In other countries there is the further difficulty of dealing with wolves.)

TETANUS.

Tetanus is an infective disease caused by the *tetanus bacillus* affecting the nervous system, and setting up tonic spasms of the voluntary muscles.

Causation.—The bacilli gain entrance by wounds, especially septic ones, most commonly lacerated or punctured, but even through burns, ulcers, or any slight injuries. Tetanus has occurred from infected catgut ligatures, and from contaminated fluids (serums, etc.), used for injections. Kicks from horses, and injuries from dirty farm implements, are specially likely to produce the disease. Certain cases called *cryptogenetic* occur where no obvious cause is found, as in many cases of *trismus neonatorum*, etc.

Predisposing causes are exposure to cold or damp; but a warm climate aids the growth of the microbe.

Pathology.—The bacillus on entering the wound grows only at the seat of inoculation, forming its poison there, but not spreading through the body or blood. The toxins are formed under favourable conditions, *i.e.* absence of oxygen; and these conditions are found in the depth of the wound, and the presence of aërobic microbes, which use up the available oxygen in the immediate vicinity of the tetanus bacilli. The toxins are probably of the nature of an enzyme, and act only after a period of incubation (four to six days); they have a special affinity for nervous tissue, and travel to the central nervous system by way of the nerve sheaths, and so reach the motor nerve nuclei.

After death, hyperæmia and degeneration of the grey matter have been observed in the cord, but not always.

Symptoms.—The first are stiffness in the neck, then trismus, or difficulty in opening the mouth (*lock-jaw*), and of swallowing; the facial muscles are drawn (*risus sardonicus*); the abdominal muscles become tense and hard. Spasms of these muscles become frequent, and extend over a wider area, till all the muscles may be involved. They occur also from a much slighter stimulus as the disease progresses (slight noises, draughts, etc.), and in the intervals the tonic contractions tend to remain, especially those of the abdominal muscles, which are often "like a board."

The pulse remains normal, except when it is hurried from the exhaustion caused by the spasm. Respiration also remains normal until the respiratory muscles are involved (a late effect), when respiratory spasm occurs. The temperature remains normal as a rule, but may be raised, especially just before death. There is profuse sweating, which causes the urine to be concentrated, high coloured, but otherwise normal. The bowels are always obstinately constipated. The pain of the spasms and tonic contractions is intense; the intellect remains clear, and insomnia is pronounced.

Death occurs from syncope, exhaustion, spasm of the glottis, or spasm of the respiratory muscle.

When the muscles of the back are specially affected the patient is arched so as to lie on his head and his heels only (*opisthotonus*); when the abdominal muscles are specially contracted, he lies curled up (*emprosthotonus*); when these are counterbalanced, he remains rigid (*orthotonus*); when those of one side are more strongly affected, he is twisted to the side (*pleurosthotonus*).

Prognosis.—The so-called *acute* cases, occurring seven days after inoculation, and culminating in generalised spasms in 1-2 days, are very fatal (80 to 90 per cent); in chronic cases, after a longer incubation, 8-14 days, and if the patient lives beyond the 12th day prognosis is more favourable (mortality, 15-20 per cent).

Diagnosis from *hydrophobia*, by the absence of hallucinations and viscid saliva, and the presence of trismus, and the tonic contractions between the spasms, and absence of fever: from *strychnine poisoning*, by the twitchings, and the rapid onset and termination of that affection; from *tetany*, by Chvostek's and Trousseau's signs; from *hysteria*, by the inexact imitation.

Treatment.—*Local*: first excise the region of the wound, and if necessary, amputate part of a limb. Dress the wound with antiseptics, and wash frequently with *hydrogen peroxide*. Hypodermic injections of dilute carbolic acid. Cutting a main nerve supplying the part only delays the onset.

General: inoculation with antitetanic serum, though only an antibacterial serum, should be tried, and in repeated doses; and there is apparently no better way of injecting than into the subcutaneous tissues.

The bowels must be opened by a strong purge, and the urine drawn off if there is retention from spasm; the diet must be light and digestible, and the body kept moderately warm in a quiet and dark room. For the spasms, chloral and bromide may be given, or inhalations of chloroform over a long period.

Prophylactic measures should be taken when a wound is badly infected with earth, manure, etc., or lacerated with a gunshot, especially if near the brain or cord, by injecting a dose of antitetanic serum, which is a reliable preventive of tetanus.

Tetany is a condition found associated with complete removal of the thyroid gland, dilatation of the stomach, rickets, etc. It is not due to an infection, but probably to some auto-intoxication.

There is tonic spasm of the muscles, which may be locally excited by stimulus—tapping on the facial nerve produces risus sardonicus (*Chvostek's sign*), and pressure on the main vessels causes spasm of the muscles of the limbs (*Trousseau's sign*). The pulse is quick, the temperature usually raised, and headache and vomiting are common. The limbs are usually flexed at all the joints.

Pathology, not clearly known.

Treatment.—General measures to promote normal digestion, chloral and bromides for the spasms.

DIPHTHERIA.

Diphtheria (membranous croup), is an infective disease caused by the *bacillus diphtheriæ*, with localised lesions usually on the tonsils and pharynx, but producing constitutional effects on the nervous system.

Pathology.—The bacilli planted on the fauces set up inflammation with formation of a fibrinous deposit (the *false membrane*), and there form their toxins which are absorbed from the mucous surface.

Symptoms.—At first malaise and fever, sore throat with white spots on the tonsils; croupy cough, husky voice, and choking fits, due to spasm, but later to blocking of the larynx from downward spread of the membrane. Paralysis of muscles, especially those of deglutition, is apt to occur. (See a medical work.)

Diagnosis, from *follicular tonsillitis*, *thrush* (caused by oïdium albicans), and *scarlatinal sore throat*, by microscopic or bacteriological examination.

Surgical **treatment** is called for in cases of choking, when it is met by *intubation* with O'Dwyer's tubes, by *tracheotomy* or *laryngotomy*. In all cases *antitoxin* should be given.

Wound diphtheria affecting the edges of the tracheotomy wound is not now common. There is necrosis of the soft parts spreading from the opening. It is treated with antiseptic dressings and caustic applications.

ANTHRAX.

Anthrax is an infective disease caused by the bacillus anthracis. It affects sheep, cattle, and other animals, and is transmitted to man by working with infected hides, wool, etc.

Pathology.—The bacillus causes at first a local inflammatory necrosis, and if not checked it affects the blood stream, setting up a septicæmia.

Symptoms.—The local form, *malignant pustule*, occurs by inoculation into a crack in the skin. A small red vesicle appears, from which a spot of gangrene spreads. The centre quickly becomes black, hence the name (*anthrax*), and the surrounding skin becomes brawny and œdematous, but without suppuration. The glands become enlarged and tender. Fever sets in, typhoid in character, and the patient is apt to die from coma or syncope.

There is a generalised form (*wool-sorter's disease*, or *splenic fever*), from infection through the lungs or alimentary canal, more rapidly fatal.

Prognosis is good in the local form if treatment is commenced early, but bad in late stages, and very fatal in the generalised type.

Treatment.—Excision of the spot with the surrounding tissues as soon as diagnosis is made. Injection of anthrax antitoxin as early as possible.

ANIMAL PARASITES.

Tænia Echinococcus, one of the cestode worms, in its intermediate stage gives rise to *hydatid cysts*. The worm is about $\frac{1}{4}$ inch long, and consists of four segments—the first being the head, and furnished with suckers and thirty or forty hooklets. It inhabits the alimentary canal of sheep, cattle, and more especially dogs.

Invasion occurs in man through drinking water infected with the eggs.

Pathology.—The eggs, on entering the alimentary canal, lose their chitinous covering and migrate into the tissues. Here they set up an inflammatory new formation which forms the capsule (*ectocyst*), and in this the true cyst (*endocyst*) is formed by development of the egg, and is composed of *germinal membrane* and fluid (slightly opalescent, of low sp. gr. 1010, containing sodium chloride, but no albumen). From this membrane are developed *brood capsules*, beginning as small hollow elevations, which become the heads (*scolices*) of the new tapeworms. These are armed with four suckers and a double row of hooklets. Besides these, *daughter cysts* are formed from the parent cyst, and others from those, and so on. The size of the cyst depends on its surroundings, and may attain to great dimensions. The seat is most commonly the liver, next the lung, and the kidney.

Symptoms are due to pressure, and depend on the situation ; later urticaria may follow rupture, or suppuration may ensue. The signs are those of a cyst (*q.v.*), and especially accompanied by a thrill on percussion, due to the loculated formation.

Diagnosis is made by the history and by exclusion of other conditions. Puncture should *not* be employed, except when the cyst is directly exposed to view.

Prognosis is good, when the cyst is easily amenable to surgical treatment ; and it often subsides spontaneously. Danger occurs, if suppuration ensues, or if it ruptures into a lung.

Treatment.—Excision, if possible, or incision and drainage (see Diseases of Regions).

Other animal parasites, rarely met with in this country, are—

Chigoe or Jigger (*Pulex penetrans*), which enters the naked foot and gives rise to a suppurating tumour.

Trichina Spiralis, a nematode worm, met with in uncooked "measly pork," etc. The embryos enter the human intestine, and migrate to the voluntary muscles, where they become encapsuled. They act by causing œdema and impairment of function.

Guinea Worm, a nematode worm, which enters the alimentary canal, and migrates till it is discharged through the skin.

Filaria Sanguinis, a nematode worm, which migrates to the lymphatic vessels, and there causes blocking, giving rise to *elephantiasis* (*q.v.*) and *chyluria.*

Bilharzia Hæmatobia, a trematode worm, which produces ova in the body. These migrate and escape from the mucous surfaces, producing amongst other symptoms *hæmaturia.*

CHAPTER III.

TUMOURS AND CYSTS.

TUMOURS.

Tumours are new formations, not due to simple hypertrophy or to inflammation.

They are *classified* into simple, **Benign**, or innocent tumours, having a structure for the most part similar to normal tissues, in which they are found (*homologous*); growing in the normal manner (*typical*); and not infiltrating the surrounding tissues; often encapsuled; not involving the glands, nor recurring after removal; and causing ill effects by pressure only.

Malignant (*cancers*), having structure different to that in which they arise (*heterologous*); penetrating and invading the surrounding tissues (*atypical growth*): without definite capsule; infecting the lymphatic glands and spreading to distant organs (*metastasis*); sometimes recurring after removal; and with a tendency to cause cachexia, and inevitable and early death.

Secondary changes are common in tumours; they may become inflamed, or ulcerated; or may undergo fatty, mucoid or colloid (*cystic*) degeneration, pigmentation, or calcification. Hæmorrhage into the substance, or abscess formation may take place; and atrophy, necrosis, or sloughing may lead to their destruction. Further, simple tumours may take on a malignant condition.

Tumours are also *classified* from their supposed seat of origin and general structure, into—

(*a*) Connective-tissue tumours, innocent and malignant (mesodermal and from endothelium of mesoderm).

(*b*) Epithelial tissue tumours, innocent and malignant (epiblastic and hypoblastic.

(*c*) Teratoid tumours, with mixed tissues of all layers.

Causation of tumours is as yet unknown, but certain conditions have undoubted influence on their growth, of which the chief are:—

1. Chronic *irritation*, very often noticed previous to the onset of tumour formation (*e.g.*, cancer of lips following smoking a hot pipe, of the tongue following irritation of a sharp tooth or syphilitic eruption; also laceration of the cervix uteri, and deposit of soot on the scrotum, etc., previous to cancer in these parts).

2. *Injury*, producing subperiosteal *blood-clots*, previous to onset of sarcoma in bones.

The actual cause of tumours has been attributed to:—

3. *Cell inoculation*, from the occurrence of metastatic tumours and from *cancer à deux*; but no conclusive evidence has been evinced.

4. *Endemic origin* from occurrence of a series of cases in one house or street; but also on insufficient grounds.

5. *Organisms*, from observation of different bodies in the cells; none of which have been shown to be constant, or to produce tumour tissue other than granuloma on inoculation.

6. *Uncontrolled cell proliferation*, from occurrence of tumours in the aged, where epithelial tissues become relatively more active as the other tissues atrophy; this does not occur after nerve paralysis.

7. *Developmental* tendencies, from the frequency of tumours growing from ill-developed structures and fœtal remnants; but in many there are no embryonic cells found.

8. *Inherited* tendencies, from incidence of tumours in families; but the occurrence is rare, and the grounds for this opinion vague.

9. *Acquired* tendencies from the frequency of cancers following worry, grief, etc.; but these are not characteristic of this disease more than others.

(A) CONNECTIVE-TISSUE TUMOURS.

(*a*) Benign.

Fibroma.—This consists of wavy bundles of dense, white fibrous tissue, originating from previously existing connective tissue, by proliferation of the cells and formation of fibrils. These are packed closely, often in whorls, with few vessels, and have cells with long nuclei lying between them. The softer and more vascular fibromata are called *fibro-cellular.* They are smooth, painless, encapsuled, homogeneous masses, distinguished from other tumours by their consistence and slow growth. They are found in intermuscular septa, and those of organs, and in the periosteum, the ovary, and intestines. In the skin they form scattered nodules over the body (*molluscum fibrosum*), or a diffuse thickening of the skin hanging in folds (*pachydermatocele*), or a raised weal after cicatrisation of some wounds (*keloid*). They are met with on the gum (soft *epulis*), in the naso-pharynx (*fibrous polypus*), in the breast (*adeno-fibroma*), in the uterus (*myo-fibroma*), combined with dilated vessels (*angio-fibroma*), and with nerves (*neuro-fibroma*) ; these last when involving sensory nerve-endings form *painful subcutaneous nodules.*

Secondary changes may occur,—fatty or myxomatous degeneration, with formation of cysts, or calcification.

Treatment.—Excise the tumour if it causes trouble. In doubtful cases where it resembles malignant tumour the excision must be wide, or a piece removed for microscopical examination.

Lipoma, fatty tumour, is developed from connective tissue, already containing fat, except when it occurs in meninges or scrotum.

Subcutaneous lipomata are developed from the subcutaneous fatty tissue ; they are closely attached to the under surface of the skin, divided into lobules and encapsuled by thin layers of fibrous tissue ; the blood-supply is small. They are found chiefly on the back, buttocks, and shoulders, and are usually single.

Signs.—They are soft, elastic, semi-fluctuant, single, and painless tumours ; the skin dimpling on being pinched up, and the edge slipping under the fingers on pressure, and no fluid escaping on puncture.

Distinguished from cold abscess, cysts, or enlarged bursæ.

Treatment.—Make an incision and shell out ; if adherent excise along with the skin.

Diffuse Lipoma is an excess of fat in the loose tissues about the chin, neck, or abdomen ; there is little lobulation, the fat is more vascular, and removal is difficult.

Treatment, constitutional, along with thyroid gland extract, for obesity.

Subserous lipomata grow from *subperitoneal* fat, and spread along the spermatic cord, or penetrate the linea alba; they are often found along with hernias, and are apt to be the starting point of one.

Treatment.—Exposure of the tumour, and excision after ligating the neck.

The less common forms are:—

Subsynovial, with bulging into a joint; where multiple, called "*lipoma arborescens*"; *submucous*, met with in the stomach and intestines, where they may give rise to intussusception; *intramuscular*, *intermuscular*, and *periosteal*; *meningeal*, on the outer or inner side of spinal dura mater, simulating spina bifida.

Secondary changes may occur,—myxomatous or fibrous, forming myxo-lipoma and fibro-lipoma, or ulceration or sloughing.

Myxoma, mucous tumour, consists of tissue similar to that of the umbilical cord. It is composed of stellate cells, fine fibrils, and mucin-containing fluid. It does not arise directly from normal mucoid tissue, but by *degeneration* of fibromata, lipomata, chondromata, and often of sarcomata. It occurs frequently in the nose as *mucous polypus*.

Appearance, when cut into, is that of a mass of pale trembling jelly, and a glairy fluid drains away. There is a tendency to degeneration, with formation of cysts, into which blood may be extravasated.

Chondroma, cartilaginous tumour, and **Osteoma**, bony tumour, grow usually in connection with bone (*vide* Diseases of Bone).

Odontoma, a tumour composed of dental tissue in varying degrees of development, arising from tooth germs or growing teeth. The chief varieties are (*a*) *follicular odontoma*, or *dentigerous cyst*. This is composed of a wall containing osseous or calcific material, representing a tooth follicle, and either thick, or thin and crepitant. The cavity of the cyst contains viscid fluid and an imperfectly developed tooth. (*b*) *Fibrous odontoma* arising from the root of a growing tooth, which it surrounds and covers over before eruption. This may be so dense that the tooth never cuts through it. (*c*) *Composite odontomas* are hard tumours originating in the jaws, composed of a disordered conglomeration of enamel, dentine, and cement (*Bland Sutton*).

Treatment.—Follicular odontomas should be opened, and the sac curetted and packed with iodoform gauze. Fibrous odontomas should be enucleated.

Angioma, tumour of blood-vessel, **Lymphangioma** and **Lymphadenoma**, tumours of lymph vessels and glands, are described under diseases of these structures.

Myoma is composed of *unstriped* muscular fibres, growing from the normal muscular tissue, and occurs chiefly in the wall of the uterus, the Fallopian tubes, or round ligament; less commonly from the walls of intestines, ureter, prostate, and muscle fibres of the dermis.

The structure is similar to that of fibroma, but may be distinguished, sometimes with difficulty, by the spindle shape of the muscle cells and the rod shape of their nuclei. They are often mixed with fibrous tissue (*myo-fibroma*). A myoma of the uterus may enclose epithelial cells, from glands, etc., in the vicinity, forming *adeno-myoma*.

(*Myoma strio-cellulare*, composed of elongated *striped* muscle cells, occurs rarely in the kidney, testis, uterus, vagina, or bladder.)

Neuroma, composed of nerve fibres and ganglia; is rare in pure form, but has been found in the sympathetic.

Traumatic neuroma (see Diseases of Nerves) is a bulb at the end of a cut nerve, consisting of new-formed nerve fibres and fibrous tissue coiled up together. *Plexiform neuromata* are fibromatous thickenings of nerve sheaths, with elongation and tortuosity of the nerve fibres, found chiefly in subcutaneous tissue.

Neuro-fibromata and *neuro-sarcomata* are fibromata or sarcomata affecting the connective tissue of the nerves.

Glioma grows from the *neuroglia* of the central nervous system. In the brain it may be encapsuled or diffuse; in the spinal cord it is diffuse, and develops round the central canal. It is composed of delicate fibrilli, and cells with round or oval nuclei and stellate processes. Sarcomatous changes are not uncommon (*glio-sarcoma*). In the cord, by degeneration and formation of cysts, the condition of *syringomyelia* is produced.

(*b*) **Malignant.—Sarcomata.**

Sarcomata are composed of immature connective-tissue cells derived from the mesoderm, in which the cells preponderate over the intercellular substance. The cells divide with often irregular mitosis, and retain more or less their embryonic type. If the intercellular substance is meagre, the tumour has a soft ("medullary") character; if plentiful, it forms a fibro-sarcoma ("*recurrent fibroid*"). Sarcomata are, *comparatively* speaking, rare tumours.

Development.—1. From normal? connective tissue—subcutaneous, intermuscular, periosteal, or glandular; from walls of blood-vessels and lymphatics; from sheaths of nerves, neuroglia, and meninges.

2. From previous benign tumours, and in inflammatory connective tissue.

3. From embryonic tissue—congenital, or appearing in malformations.

They develop usually in one spot, but sometimes in many (as in multiple sarcomas of the skin).

There are several varieties of sarcoma, distinguished by the nature of the cells.

Round-celled Sarcoma forms a soft, rapidly growing tumour, composed of round cells, with a spherical nucleus and very little intercellular tissue. At the growing edge the cells are seen in small masses, penetrating the neighbouring tissues, and often with a zone of inflammation beyond. The blood-vessels are mere channels running through it, and lymph spaces are absent.

There is a variety known as *large-round-celled* sarcoma, the cells being of unequal size, and containing two or more nuclei, and often showing an alveolar arrangement of the cells.

Round-celled sarcomas arise in any part of the body, most commonly the periosteum and subcutaneous tissue, and in organs, such as the testis and breast. They occur at all ages from infancy to old age. They grow rapidly and invade the adjacent tissues. As they approach the skin, it becomes livid and thin, and the superficial vessels enlarge. The skin breaks, and the tumour presents as a fungating mass ("*fungus hæmatodes*"). The corresponding lymphatic glands may be involved, but are often enlarged from inflammatory irritation alone. Metastatic growths are common,—in the lungs, showing their presence by giving rise to cough and bloody spit; in the liver, by enlargement or jaundice; and in the skin, by formation of nodules or discoloration. Death soon follows.

Lympho-Sarcoma is a round-celled sarcoma of lymphatic tissue, formed in lymphatic glands, tonsils, Peyer's patches, spleen, and thymus or other lymphoid tissue. It is distinguished from ordinary round-celled sarcoma by the presence of reticulated stroma, in which are thin-walled vessels; and from inflamed glands by the absence of differentiated cortex and medulla. It tends to infiltrate neighbouring structures, or to perforate a vein, and spread along the lumen. Invasion of other glands is common, and death may be caused by pressure in the mediastinum, etc.

Spindle-celled Sarcoma is composed of spindle-shaped cells of various sizes, arranged in bundles, not regularly in whorls, but in different directions. On section it appears pink or grey, and the blood-vessels are few and thin-walled. It may be separated from the normal tissues by a capsule of inflammatory tissue. The growing margin is apt to show rapidly dividing cells invading the normal structures, hence if these tumours are shelled-out, they are apt to recur (*recurrent fibroids*). They may have to be distinguished from chronic inflammatory tissue, especially gummata.

Myeloid Sarcoma consists of round or spindle cells, with a large number of giant cells, *i.e.*, large irregular cells with many nuclei. The tumour is soft and elastic, and of a deep red colour. It is found as a central tumour of bone. As it grows in size the inflammatory zone causes absorption of bone, while a fresh layer is deposited from the distended periosteum, forming a thin shell. The tumour usually breaks through this, penetrates the muscular structures, and invades the skin, where it fungates.

These tumours are of slow growth, and do not usually recur on complete removal, and metastases are not common. They are liable to myxomatous degeneration and cyst formation.

Mixed-celled Sarcomata,—Chondro-, Osteo-, Myxo- Sarcomata, are round-, oval-, or spindle-celled tumours, with formation of cartilage or bone between the cells, and often cysts (serous, mucous, or blood) when mixed with myxomatous cells.

These changes usually point to slow growth of the tumour, and are so far favourable. Other tumours with cartilage-like tissue originate from endothelial cells.

Alveolar Sarcomas assume, contrary to the general rule, a more or less alveolar arrangement. The cells of large size are arranged in masses lying in a vascular tissue stroma. They are considered to arise from the endothelium of blood or lymphatic vessels, and form the **Endotheliomata**, and simulate in many respects the carcinomata.

(*a*) *Lymphangio-sarcoma* arises from the endothelium of serous membranes, and of the lymph spaces of the breast, testis, parotid, and skin, especially in moles and warts, and possibly also of the spleen and lymphatic glands. The cells, which are cubical or cylindrical, divide rapidly and often develop between them a hyaline substance which resembles cartilage. This is apt to undergo cystic degeneration, sometimes with a deposit of lime salts, which gives rise to the so-called *psammoma* or sand tumour found in the meninges.

(*b*) *Hæmangio-sarcoma* arises from capillary blood-vessels, and the tumour cells are seen spreading along the lumen (*intravascular*), or forming masses outside them (*perithelial*). The vessels have often a plexiform arrangement, and the great vascularity of the angiomata is sometimes indicated by pulsation and occasionally by a blowing souffle. These tumours are found in the testis, kidney, ovary, salivary, thyroid, and mammary glands.

Melanotic Sarcomas are round-celled or alveolar sarcomas, black or dark in colour from the presence of pigment (melanin). They develop from pigmented moles, and from the choroid, probably from the endothelium. They are very malignant, *i.e.* the growth is rapid, and there is early and wide-spread metastasis—the secondary tumours being often very deeply pigmented. Pigment may be found in the urine in the late stages; the colour which develops from melanogen appears only after standing for some time.

Treatment of sarcoma is extirpation of the tumour along with any capsule it may have (*v.* also diseases of special tissues and regions). It has been noticed that erysipelas occurring in a patient suffering from sarcoma has sometimes caused atrophy of the tumour: hence sterilised cultures of streptococci have been injected with that object (*Coley*). The immediate constitutional effects are extremely distressing,—rigors, fever, headache, etc.,—which, however, soon pass off. The ultimate results are uncertain and usually disappointing; and this treatment should be reserved for inoperable cases.

(B) EPITHELIAL TUMOURS.

Epithelial tumours are new growths formed by the epithelium of surfaces and glands, along with a connective-tissue base.

(*a*) **Benign.**

A **Papilloma** consists of an axis of connective tissue containing blood-vessels and covered with a layer of epithelium, arising from skin or mucous membrane. The papillæ are often branched, and project from the surface with a separate vessel to each branch, and the epithelium is thicker than normal. There is a clear line separating the epithelial layer from the basement, into which it does not penetrate. Papillomas are liable to bleed, and may become malignant.

Varieties :—

Warts occurring on the skin consist of an overgrowth of papillæ with thickening of the horny layer of epithelium. These are often the result of infective irritation, and are common on the hands of children. They occur also on the penis, anus, etc., from irritation of gonorrhœal discharge. True warty tumours are found in congenital *ichthyosis*, and the *verruca senilis* in the aged.

Villous papillomata are growths from papillæ of mucous membranes. They are often pedunculated, with delicate branching projections like intestinal villi (in bladder, rectum, etc.), or may be broad-based and sessile (larynx, nose, kidney), and may form a lobulated mass like a cauliflower.

The infective (inflammatory) forms, *condylomata* and *mucous patches*, are flat elevations of connective tissue and epithelium, infiltrated with inflammatory cells, appearing at the junction of skin and mucous membrane (at the anus, etc.), secreting a syphilitic infectious poison.

Intra-cystic papillomata are sometimes seen springing from the epithelium of mammary and parovarian cysts.

Treatment.—True papillomata must be completely excised, with removal of a wide area of skin and subcutaneous tissue, to prevent recurrence in doubtfully malignant cases. Infective warts should be cauterised, and kept dry to obviate spreading by their discharge.

Adenomata are circumscribed tumours growing from secreting glands, and similar to normal gland tissue, but with no secretion or a perverted one. They do not invade neighbouring structures by penetration of epithelium, nor form metastatic growths, nor recur on complete removal; ill effects, or death, occur from mechanical causes, such as pressure, etc. Adenomata are common in the mamma, ovary, and thyroid, and in the intestines and prostate.

They are met with in early life, and are progressively less common after thirty. They sometimes originate in glands previously diseased, but often without any such history.

Tubular adenomata arise from tubular glands such as those of the uterus or intestine, or the ducts of the kidney, ovary, liver, and breast. They are composed of simple and branched tubes lined with cylindrical or cubical epithelium. If they project from the surface they form *polypoid* masses.

The *acinous* variety occur in alveolar glands (breast, sebaceous glands), and consist of groups of acini lined with spheroidal epithelium, and communicating with one another.

Papilliferous adenomata are produced by papillomatous growths projecting into the alveolar spaces.

Adenomata may be *modified* by proliferation of connective tissue forming *fibro-adenoma*, or by cyst formation, producing *cystic adenoma*.

Treatment (*vide* Diseases of Regions).

(*b*) **Malignant (Epithelial Cancers).**

The essential character of a cancer consists in an unlimited multiplication of the epithelial elements of the organ attacked. The cells form outgrowths into the adjoining connective tissue; and their development causes an inflammatory infiltration in the immediate vicinity, by which the normal cells are displaced and disintegrated, their place being taken by the cancer cells.

Epithelial cancer is more especially a disease of later life: the incidence being progressively greater after thirty. Certain organs are more liable to it, especially those which are in a state of involution, such as the breast and the uterus (hence the prevalence of cancer amongst women), and the prostate; or which are subject to long-continued irritation, as the lips amongst clay-pipe smokers.

The *cause* of cancer, as of other tumours, is still purely conjectural.

Clinically the presence of cancer is characterised by marked emaciation and cachexia, even in the absence of septic absorption.

They are distinguished by the character and arrangement of the cells forming the tumours.

Epitheliomas are composed of stratified epithelial cells derived from skin or mucous membrane, like papillomas, but differing from them in that the epithelial cells penetrate the basement membrane into the connective tissue, forming flask-shaped projections. The deeper layers often contain "*cell nests*," *i.e.* concentric layers of squamous cells, the central ones being horny. Around the irregular growing margin is a zone of inflammatory cells, giving rise in chronic cases to well-marked cicatricial hardening. The cells are carried to the corresponding glands, without, however, necessarily involving the lymphatic vessels on the way. Here they form secondary growths, sometimes of great size, and affect many glands, giving rise to severe pressure effects. Dissemination to distant parts is rare.

Course.—An epithelioma may rise from normal skin or mucous membrane, especially at their junction; and it commences as a warty tubercle with raised, indurated edges, with irregular outline and a hard base, not sharply defined; or it may rise in an old scar tissue (*e.g.* leucoplakia), ulcer, or previously benign growth. The surface ulcerates and fungates, and shows little tendency to heal. The glands, though infected early, may show little enlargement, but some tenderness.

Progress.—Death occurs from complications connected with the primary growth or the enlarged glands, such as septicæmia following ulceration, or involvement of neighbouring structures.

Treatment.—Free removal of the tumour as soon as it is diagnosed, cutting well beyond and below the limits of the disease, lest recurrence takes place in the scar. Also excision at the same time, or soon after, of the corresponding lymphatic glands. If the tumour recurs it must be treated in the same way, where it is accessible.

Palliative Treatment in inoperable cases consists in relieving pain, by opium or other drugs, or in some cases by section of nerves; and in prevention of septic absorption by antiseptic measures. Large fungating, sloughing tumours may be often made more aseptic by partial excision or cautery, to get a clean surface. Obstruction of larynx, urethra, etc., must be treated surgically also.

Rodent Ulcer, an anomalous form of epithelial growth on the skin, usually at the edge of the nose or canthus of the eye. Its structure is similar to that of squamous celled epithelioma, but the cells resemble those of sebaceous glands, and there are rarely cell nests present.

The growth begins as a small nodule beneath the epithelium, but ultimately an ulcer forms with clean-cut edges and a base, pale in colour and showing no granulation. Growth is very slow, the glands are not involved, and metastatic growths do not occur.

Treatment.—Excision, if not spread too deeply. The application of X-rays has a marked curative effect, often healing it in a very short time, leaving a good cicatrix.

Chorion-epithelioma (*deciduoma malignum*), a malignant tumour arising from the epithelial cells of the chorion, after a confinement or abortion; spreading into the uterus, and rapidly forming metastatic growths. It is characterised by irregular bleeding, anæmia, and sometimes fever. It is quickly fatal if not removed along with the uterus.

Carcinomata (gland cancers) are of two varieties.

1. **Tubular**, composed of irregular tubes lined with cylindrical epithelial cells, growing from columnar epithelium, tubular glands, and the ducts of racemose glands. The cell layer may be single and the lumen of the tube free, but in quick-growing tumours the lumen is filled by layers of cells, the more central of which are almost spherical in shape. Around the epithelial cells is a varying amount of fibrous tissue, and beyond this a zone of inflammatory round cells. The thickening is small in the soft variety, but may be marked in the slower-growing annular carcinomata of intestines, and in the stomach. There is no true capsule, and the epithelium penetrates irregularly into the adjacent connective tissue. The lymphatic glands are affected early; and complications are frequent, owing to the hidden situation of many of the tumours until they become formidable. There are apt to be obstructions of various kinds, and hæmorrhage or ulceration, with septicæmia often causing death. Papillary outgrowths are met with in cancer of the rectum and bladder, and these readily break down and bleed.

They vary in malignancy according to situation; duct cancer of the breast being least malignant, while cancer of rectum and stomach are often amenable to surgical removal; on the other hand, cancer of the pancreas is very fatal.

2. **Acinous** carcinoma is composed of epithelial cells, spheroidal in shape, and growing in connection with racemose glands; and retaining that character, though very atypically, in the primary and secondary growths. Of this variety there are two indistinct divisions, differing in their chronicity and consequent amount of inflammatory fibrous new-formation, viz.—

(α) **Scirrhus**, where the fibrous tissue may be so abundant that the central part consists of little else; though the growing edge has the cellular alveolar arrangement, with invasion of the surrounding tissues, preceded by an area of inflammatory round cells.

Clinically these tumours are hard and nodular; with puckering of the skin, and in the breast retraction of the nipple, due to cicatricial shrinking. On section the surface becomes concave, and it grates on scraping. They grow slowly, and in some cases they atrophy and become smaller by fatty degeneration. Lymphatic glands are affected early, and they are apt to grow more rapidly than the primary tumour, but are usually of hard consistence. Metastases of the same kind occur in the liver, bones, etc., causing death at an early stage. If the tumour reaches the surface a chronic ulcer is formed, with indurated, everted edges, and a base of tumour tissue covered with granulations, secreting a thin sanious discharge.

(β) **Medullary**, soft, spheroidal-celled carcinoma, having little fibrous tissue, but what connective tissue there is being very vascular. The tumours are fast-growing, and the alveolar spaces are filled by layers of cells. At the margins the cells are seen spreading into the surrounding tissues, but owing to their rapid encroachment the zone of inflammation is absent or very slight.

The tumours are soft and elastic, or semi-fluctuant, and in section they are of greyish pink colour ("**encephaloid**—brain-like"), or red and pulpy. The centre is liable to fatty degeneration and softening with extravasation of blood. They tend to fungate and bleed, and to suppurate, often with a foul discharge. They grow rapidly, and infect early the lymphatic glands and vessels, and the surrounding connective tissue, forming an ill-defined, spreading tumour. Metastatic growths develop early in the lungs and liver from numerous foci.

Colloid Cancer is a glandular cancer in which degeneration of the cells has taken place, and the alveoli are distended with a gluey fluid. The cells lining the alveoli are atrophied towards the centre of the tumour. It is met with in carcinoma of the omentum and other abdominal structures.

Course.—Carcinomata begin insidiously, often without pain or signs of swelling, until the tumour has spread deeply, or secondary growth has taken place; this is especially so in internal organs. The first sign is often due to impairment of function, such is intestinal obstruction, etc. Pain is due to involvement of nerve-endings or stems, and otherwise may be absent. When ulceration takes place cachexia becomes marked, *i.e.* septic anæmia and wasting.

Progress is steadily towards death, in uncomplicated cases from exhaustion.

Treatment.—Excision of the tumour, along with a sufficiency of surrounding tissue, especially fatty connective tissue, the corresponding lymphatic glands, and the lymphatic tracts between these. This is especially needful in the softer and more malignant cancers. Other methods than excision are illusory. In cases doubtfully malignant, a small piece may be excised for examination.

Cure.—If recurrence takes place after operation, it does so usually within a year, hence a cure may be considered to have been obtained if there is no recurrence in three years. This is not absolute, as recurrences take place even after six years or more.

Palliative measures, as in other cancers, are confined chiefly to asepsis and opium. In the case of the alimentary tract it is sometimes necessary to short-circuit it on account of obstruction (*e.g.* by gastrostomy, gastro-enterostomy, etc.) Cancers of the uterus and mouth, if much ulcerated, may be made more aseptic by curetting and cauterising the surfaces to prevent formation of pockets for pus to lodge in.

(C) TERATOMATA.

By **Teratoma** or *teratoid tumour* is meant a congenital malformation composed of connective tissue and epithelium, originating either by misplacements of embryonic tissue in a single fœtus; or as a double malformation following the fusion of two embryos, when one comes to maturity at the expense of the other.

Among the first class the chief are **Dermoid Cysts.** These are cavities whose inner walls have the structure of normal skin and its products, viz. sebaceous glands and secretion, and hair—cartilage, bone, and teeth being sometimes found in them, and in rare instances muscle and nerves. Dermoids occur most frequently in the ovary, and in the neck, skull, orbit, and peritoneum, and but seldom in other organs.

The other class is represented by "*congenital sacral tumours*," and "*double monsters*."

These tumours are on the whole rare.

Treatment.—Owing to the tendency for these tumours to become malignant they should be excised. In the case of double monsters it depends entirely on the formation of the connecting link what operative measures are allowable.

CYSTS.

A **Cyst** is a sac containing fluid, originating from accumulation of secretion in a cavity, or from degeneration of tumours. They are classed as follows:—

Retention cysts formed (*a*) *in glands*, when the opening is blocked, *e.g.* sebaceous cysts or hydronephrosis; (*b*) from blocking of *mucous canals*—mucoceles—*e.g.* hydrosalpinx; or (*c*) *mucous cavities*, *e.g.* antrum of Highmore; and (*d*) from obliteration of *lymph channels*—lymph cysts.

Exudation cysts, from increase of inflammatory secretions, *e.g.* ganglia and adventitious bursæ.

Extravasation cysts, *e.g.* hæmatoma.

Congenital cysts, arising from fœtal glands or tubes not being completely obliterated, and becoming distended with fluid. They occur in the *tunica vaginalis testis*, and various rudimentary structures of the *ovary* and *testis*, and in the lines of the *branchial clefts* and the *urachus*.

Dermoid Cysts (*see* Teratoma).

New-formation cysts, *implantation cysts*, from a fragment of epithelium being accidentally carried into the subcutaneous tissue and giving rise to a cyst; arising also from *degeneration of tumours*, *e.g.* colloid cancer.

Parasitic cysts, of which the chief are from the growth of *Tænia echinococcus* (*q.v.*).

Treatment.—Whenever possible a cyst should be dissected out with its walls unopened. If this cannot be done it should be opened and drained with gauze packing; sometimes the cavity is scraped or cauterised with pure carbolic acid, and allowed to heal by granulation. A cyst should never be tapped with a needle for diagnosis, unless preparations are made to follow up with wide incision if necessary.

CHAPTER IV.

WOUNDS AND THEIR TREATMENT.

WOUNDS.

Wounds are of two kinds—simple or aseptic, and poisoned, by which is understood *infected*. The former heal by "first intention," the latter by granulation; the distinction, however, is an arbitrary and clinical one, the process being similar in both, except in the matter of degree.

Healing by First Intention.—When a wound is made in a healthy subject the irritation sets up a mild degree of inflammation, especially acceleration of blood stream and emigration of leucocytes. The blood-vessels retract, their orifices contract, and bleeding stops by formation of thrombi. Some of the tissue cells are killed and others damaged; these are removed later by phagocytes. If the surfaces of the wound are now brought accurately together, it is found that they become coated with a thin layer of clotted blood and plasma, which acts as a binding material in the first place, and as a groundwork for granulations to form in later. Leucocytes and serum fill up any irregularities between the surfaces, while the connective-tissue cells in the neighbourhood commence to proliferate. These ultimately replace the leucocytes and blood-clot, become elongated in shape (fibro-blasts), and join the two layers together by fibrous tissue.

Meanwhile the closed ends of the capillaries begin to throw out buds into the mass of cells. These form loops, which become hollowed out into new capillaries, and join with similar adjacent loops and those of the opposing surface. These vessels, with a groundwork of proliferated connective-tissue cells and leucocytes, constitute **granulation tissue.**

At the same time the epithelial cells at the surface spread over the ridge of granulation tissue by proliferation of the layer.

Cicatrisation.—In course of time the scar-tissue cells contract, and in doing so tend to condense the tissue, and also to obliterate many of the new-formed capillaries; thus the scar becomes hard and pale. The process is practically the same whatever the size of the wound or the nature of the tissue, provided that the surfaces are in contact, and that they are not irritated by microbic or any other means.

The constitutional effects of such wounds are small. The temperature and pulse-rate are hardly raised, and pain disappears in one or two hours if the part is kept quite still. After an operation any other sign of discomfort is due to the anæsthetic, or to simple traumatic fever produced by the poisonous products of the destruction of blood-clot or other tissues, apart from septic influences, and probably due to fibrin ferment. This causes a rise of temperature to 100°-102° F. commencing in a few hours, and falling in 12-36 hours, according to the amount of effusion.

Healing **by granulation** occurs when a wound has been kept open, or when it fails to unite on account of (*a*) sepsis, followed by suppuration, either taking place at the time of inflicting the wound or from infection later; or (*b*) excessive damage to the tissues; or (*c*) accumulation of serum between the surfaces; or (*d*) sliding of the faces of the wound, from not keeping the part at rest. Delay in healing occurs from states of ill-health—such as diabetes and Bright's disease—and this also increases the liability to sepsis.

In an open aseptic wound the superficial cells usually die off, and the surface becomes covered with granulations, which secrete a clear serum with a few leucocytes. If the surfaces are now approximated they will unite as in the first instance, leaving a little thicker scar. If the wound is much damaged, and especially if it is septic, the layer of necrosis is much deeper and lasts much longer, and the wound is practically in the position of an ulcer. Under dressings which are antiseptic and absorbent the wound fills with granulations until the level of the skin is reached. The new-formed fibrous tissue begins to contract, and thus approximates the edges of the wound. The epithelium spreads towards the centre, and will cover the scar if it is not too large.

The constitutional effects of such wounds depend on the amount of absorption. In clean open wounds there is very little disturbance, but in closed wounds which have become septic the condition is very different. The slight fever due to simple traumatic causes does not abate, and in thirty-six hours or so the patient feels chilly, and may have a rigor. The temperature rises (102°-103° F.) and the pulse becomes rapid, the tongue coated, and the bowels confined, the skin hot and dry, and the urine scanty. There is headache, loss of appetite, restlessness, insomnia, and sometimes delirium. The patient complains of pain or tightness of the bandages. The edges of the wound are seen to be red and œdematous, and the wound cavity distended. If a stitch is removed fluid escapes, at first blood-stained and purulent serum, but pure pus later (*i.e.* three days or so after infection), and the wound in fact becomes an abscess cavity. If many of the vessels are reopened blood will be mixed with the pus; when a large vessel is reopened in this way severe hæmorrhage takes place. This is known as *secondary hæmorrhage* occurring after wounds. *Cellulitis* may spread from the wound, leading to sloughing and destruction of wide areas, and *pyæmia* may ensue, with dangerous or fatal results. If the process is checked in time the wound heals like an ulcer.

TREATMENT OF WOUNDS.

The aseptic treatment of wounds is founded on two recognised principles: first, that the *healthy*, unexposed tissues of the body are sterile; and second, that septic diseases of wounds are due to microbes introduced from without. Closed wounds, therefore, tend to heal by first intention, unless they are prevented by septic infection, or by distension with blood or other fluid.

The sources of infection being now recognised, viz. the skin, ligatures, sutures, instruments, dressings, and the air, it follows that all these should be disinfected before coming in contact with a wound. The skin can only be disinfected approximately; while the air, though it can be largely discounted in most cases as a source of infection, should always be as pure and as still as possible. All else coming near a wound can and should be made sterile.

Germs of wound infection can be combated by—

1. Removing them, without necessarily killing them.
2. Killing them by germicidal agents. (Disinfection.)
3. Preventing their growth and development. (Antisepsis.)
4. Counteracting the poisons produced by the microbe.
5. Rendering the body immune to their attacks.

The most strenuous cleanliness in every surgical undertaking is of more importance than anything else that can be done to guard against infection.

1. Microbes are **removed** *mechanically* by scrubbing, washing, and flushing, and *chemically* by using solvents such as turpentine, soda, etc. The use of hard polished materials for instruments, tables, and bowls, greatly facilitates this, hence the so-called "aseptic" instruments and furniture.

2. Microbes can be **killed** by heat or chemicals (*vide* p. 28). All metal, glass, or rubber instruments, all silk and silkworm-gut should be boiled for fifteen minutes in water. The addition of 1 per cent sodium carbonate (washing soda), or borax, will prevent rusting of steel instruments, and also raise the boiling point to 104° C. Needles and knives, if their cutting edges are properly protected, are not injured by this temperature; while soft or vulcanised rubber, good gum-elastic, and horse-hair also stand this temperature, but not soda, and should therefore be boiled in plain water. Towels, gauze, and swabs may be boiled, but are more conveniently used dry; and they, with wool, bandages, binders, sheets, aprons, etc. should be steamed for thirty minutes. Whether the large Schimmelbusch's sterilisers or small potato steamers be used, the result is equally good, *provided* that in the latter the steam is allowed to pour out in a steady jet, showing that the temperature is kept at 100° C. The closed "autoclave," with steam under pressure, is not reliable, except for small articles into which the steam can penetrate easily, or for fluids in flasks.

Dry heat, in the form of flame, is used only for hypodermic and vaccination needles and the like; and hot air sometimes for catgut, and powders (salt, talc, etc.). "Flaming," *i.e.* pouring alcohol into a vessel and burning it out, is quite unreliable.

Articles that cannot conveniently be subjected to steam or boiling water, such as gauze impregnated with antiseptic salts, catgut, reindeer tendon, and the skin of the patient and surgeon, must be disinfected with chemicals. In all cases these must be allowed to act for a sufficient time and in a large excess.

Special disinfectants used in surgery:—

Carbolic Acid, in watery solution of 1 in 20 kills cocci in a few minutes, but spores only in 30 days; when applied to pus or blood a long time must be allowed to penetrate. Solution of 1 in 100 is a useful *antiseptic* lotion, for storing sponges, etc., and rinsing the hands at an operation. Pure carbolic is used as a caustic; it is a local anæsthetic, so causes little pain; it kills germs in the presence of water in the tissues. Solutions in *oil* are nearly inert, and in *glycerine* weak. *Alcohol* neutralises the caustic action of pure carbolic acid when mixed with it. It is a strong irritant to the tissues (*see* Gangrene).

Cresols (*Lysol*, *Izal*, *Jeye's fluid*, *Creolin*, etc.), insoluble in water, but soluble in soaps, are useful in the same strengths as carbolic acid.

Mercuric Chloride (*corrosive sublimate*) is used in 1 in 1000 solution; it kills cocci in a few minutes, and spores in 20 to 30 hours; but forms inactive albuminates in pus and blood. It is irritating to the tissues. Solution of 1 in 500 is a strong disinfectant, but much more irritating.

Mercuric Iodide, used in the same strengths, is more useful, as it is not precipitated by pus and blood.

Formalin, in solution (or vapour, in the presence of water vapour), is a powerful germicide; used to disinfect gum-elastic and other instruments which cannot well stand heating. It is used also to prepare catgut.

Iodine, the tincture is a strong germicide, and may be used to disinfect the skin in certain circumstances.

Aluminium acetate, used especially against B. pyocyaneus.

Chromic acid, used to harden and disinfect catgut.

Silver salts, used chiefly against gonococcus.

Essential oils used to disinfect catgut, etc.

Alcohol is a weak disinfectant, and is generally used as an antiseptic.

3. Growth is **inhibited** by antiseptics (*vide* p. 27). These are specially of use in wounds already infected, or situated near some source of infection. Antiseptics are used (*a*) to wash out a wound or abscess cavity, where the action is mainly mechanical, and (*b*) as a permanent application in contact with the surface.

(*a*) The most commonly used lotions are:—

Boracic (or **Boric**) **acid**, saturated solution, *i.e.* 4 per cent.

Carbolic acid, 1 in 40 and 1 in 100 solution.

Corrosive sublimate, 1 in 1000 to 1 in 10,000 solution.

Potassium permanganate, 2 per cent solution.

Aluminium acetate, 2 per cent solution.

Peroxide of hydrogen solution, which effervesces on coming in contact with albuminous fluids, and so helps further to clear away septic particles.

(*b*) As continuous applications they are generally used in gauze or lint impregnated with the substance.

Boracic lint, with the acid crystallised from a saturated hot solution, and dried—an unirritating dressing, useful for superficial wounds; it must be frequently renewed as the antiseptic power is small, and the crystals are easily washed away by a profuse discharge.

Corrosive sublimate, in gauze or wadding (1 in 1000), a cheap and reliable dressing; apt to irritate tender skins. It also is very soluble. It is often applied to the skin before an operation.

Double cyanide of zinc and mercury (1 in 1000), used like the foregoing, but less irritating; and owing to its comparative insolubility it is not readily washed out of the gauze by copious discharges. It must always be *disinfected* before use, and this is most easily carried out by damping it with carbolic (1 in 20), and storing it in an air-tight jar for several days. A very useful material for a wound dressing or for packing cavities.

Iodoform in gauze, 10 per cent, is used for packing cavities, to stop bleeding, and as an antiseptic dressing. Iodoform as an emulsion with oil or glycerine is used for injecting into tubercular tissues, against which it is said to have a specific action. It is also used as a dusting powder, plain or mixed with boric acid (1 to 4), or as a paste made with sublimate solution or spermaceti for filling bone cavities. As iodoform by itself has no germicidal properties until it is decomposed, and is apt to harbour germs, it must be sterilised. For pastes or emulsions the powder may be wetted with sublimate or carbolic, and gauze may be treated thus, or, like powder, may be sterilised with steam, provided that it is packed in a thick layer of cotton wool, otherwise it will be evaporated away.

4. The **poisons** produced by the microbes may be **counteracted** by injecting antitoxins, as in the case of diphtheria.

5. The **body** may be rendered **immune** to their attacks by injections of antibacterial serum, as in the case of antitetanus serum, which may be used in soiled lacerated wounds, especially about the head, when there is a fear of that infection.

ASEPTIC OPERATIONS.

As has been said, the skin can only be partially disinfected, as microbes are normally found among the superficial epidermis cells, around the hair bulbs, and to some extent in the ducts of the skin glands; nevertheless, for surgical purposes the **surgeon's** *hands* may be prepared in the following way (Kümmell and Fürbringer):—

1. The hands and fore-arms are scrubbed in hot water with a sterilised brush for five minutes by the clock. The nails are cut close, and a blunt nail-scraper is used around the nail beds and under the nails during this washing. Plenty of soap, preferably "soft," and very hot water, if possible sterilised, should be employed. Running water is best, but failing that several changes must be used.

2. The hands are dried and rubbed with a rough sterilised towel, or at least one fresh from the wash, in order to remove the loose epithelial scales.

3. They are then rubbed in 80 per cent alcohol with a piece of gauze for one minute. Ordinary methylated spirit may be used, as the water in the skin soon dilutes it sufficiently. It acts by hardening the skin, and enclosing any microbes left behind, and also prepares the skin to absorb the following lotion :—

4. The hands are soaked for one minute in 1-1000 sublimate, or 1-20 carbolic lotions, whichever the hands can best tolerate. This is repeated frequently during the operation, to remove any microbes which are brought to the surface.

Other methods of hand disinfection are, scrubbing the hands as in stages 1 and 2 of the preceding method, and (stage 3) soaking the hands in hot saturated solution of potassium permanganate till they are mahogany-brown; and (4) in hot saturated solution of oxalic acid to whiten them (Kelly). Also by scrubbing the hands in a basin of spirit-soap for 5 minutes, and wiping them with a sterile towel, thus leaving them covered with a thin film of soap; the hands and sponges being used dry (Mikulicz).

Some surgeons use sterile cotton gloves, but though they are of help for tying ligatures, etc., they are, on the whole, troublesome to use. With greater reason rubber gloves are recommended for all septic cases, to protect the surgeon; and also for all assistants and nurses helping at any operation, where no delicate work is required of them. The hands in each case must be prepared as usual.

The surgeon and his assistants clothe themselves in sterilised cotton aprons, with sleeves reaching to the elbows. For private work these may be made of quite thin material, to save bulk in carriage.

The **patient's** *skin* requires equally careful preparation. If possible he is given a warm bath the day before operation, with the free use of soap and a bath brush. Clean linen is provided for him, and the bed has fresh sheets. The skin, over a wide area round the part to be operated on, is shaved, scrubbed for five minutes with soap and water, and dried. It is rubbed either with ether, or with turpentine followed by spirit, to remove it and prevent blistering, then with 1-1000 sublimate solution. (Carbolic, 1-20 may be used for this purpose, except in the case of children, who are apt to suffer from absorption through the skin.) If the part is prepared some hours before the operation, a compress of lint wrung out of the same is fixed over the part with a bandage. This should *not* be covered with a waterproof dressing as it causes the skin to become sodden, and encourages the growth of microbes in the deeper layers of the skin. Before operation the dressing is removed, and the part well rubbed with spirit and sublimate solution.

If the skin gets blistered by too vigorous treatment, it is better, when the case is not urgent, to wait until it is restored to its smooth state by ointment dressings, otherwise troublesome stitch abscesses are apt to appear.

The patient's *hairy scalp* should in all cases be wrapped in a sterilised towel, and fixed with a bandage wet with sublimate. This is especially needful in operations about the face or neck.

Disinfection of *mucous membranes* is still less certain, as they cannot stand the application of disinfectants. The mouth or vagina must be cleansed mechanically, by rubbing with gauze and hot water and soap, or a weak antiseptic like boracic acid.

The *teeth* should be thoroughly cleaned before all operations, and any necrosed part scraped, and touched with pure carbolic. In operations in the mouth, especially plastic operations, all diseased teeth should be extracted some days before, to obviate disappointing infection of the wound.

The *alimentary canal* is prepared by free purging with salts, when that is possible, and by emptying the lower bowel by means of enemata. This flushes the bowel and removes a large number of microbes from its walls.

For ordinary operations it is sufficient to give a laxative, twenty-four hours before, followed by an enema of soap and water at night. In the morning a cup of clear soup or a nutrient enema may be given, but no solid food in any case for four hours before operation, as anything lodging in the stomach causes vomiting when the anaesthetic is given.

The **operation room** must have a good light,—north daylight from the roof is best, with several hanging electric lamps for night work. The walls and floors should be smooth, easily cleaned, and not destructible by repeated scrubbings. In *private practice*, if time allows, a well-lighted room should be cleared of furniture, curtains, carpets, and pictures; it should be well washed and dusted with a damp cloth, and thoroughly aired, the day before the operation. In emergencies it is much safer to disturb furniture, carpets, etc. as little as possible, and especially, not to raise dust by sweeping the floor the same morning. Clean sheets, if available, may be used to spread over the dusty carpets. At night an abundance of candles gives the most efficient light in the absence of electricity or gas. They are more convenient for using at close quarters, and less dangerous than oil-lamps.

There must be an ample **water**-supply, and always some sterilised water for making saline solutions for injections and flushing wounds. (In private this can be arranged by having cleansed ewers filled with boiling water, and allowing them to cool, covered with clean towels.) *Physiological saline solution*, *i.e.*, 0·9 per cent, is best made by adding a small flask of concentrated salt solution to a ewer of known capacity filled with boiled water. For intra-venous or intra-abdominal injection this should be carefully measured; for subcutaneous injection or for flushing purposes one teaspoonful of salt to the pint is accurate enough. Concentrated sterile salt solution can be conveniently stored in the bottles sold for sterilising milk.

All the tables, basin-stands, and other **furniture**, are scrubbed with hot water and soda,—if possible the basins should be wrapped in towels and steamed; if not, they should be rinsed out with sublimate 1-1000; the tables are covered immediately before the operation with sterilised towels, or in their absence with fresh towels wrung out of sublimate.

The most convenient *operation tables* are those provided with hot-water pans, and can be adapted for the "Trendelenburg" and "lithotomy" positions. (In private, a strong kitchen table is best for the body, and as it is rarely long enough, a small "occasional" table is sufficient to support the legs; in operations on the perineum this can be quickly removed and the patient put in the lithotomy position.) The table is covered with a thin padding and a mackintosh, and a sterilised or freshly washed sheet is spread over it just before the patient is placed on it.

Ligatures—of *silk* are prepared by boiling in 1-1000 sublimate solution in a jar, and taken directly out of it without removing the antiseptic. *Catgut*, is used plain or treated with chromic acid to make it less soluble and retain it longer in the tissues. It is chromicised by soaking in chromic acid, 4 per cent in dilute glycerine. Soaked for 1 hour it remains unabsorbed in the tissues 10 days, for 48 hours 3 weeks, for 96 hours 5-6 weeks; it is further disinfected and stored in carbolic glycerine (1-5) (*Macewen*). Raw commercial catgut may be sterilised by soaking it in 1 per cent solution of iodine in iodide of potassium (1 per cent) for eight days; at the end of that time it is ready for use: it is almost black in colour, soft and elastic, but rather slippery (*Claudius*). Raw catgut is also prepared by removing the grease with ether, and disinfecting it in juniper oil for several months (*Kocher*), or sublimate-alcohol 1 per cent for 2 or 3 days (*Bergmann*); or more safely by boiling it, after dehydration, in cumol (*Krönig*), xylol (*Mayo Robson*), absolute alcohol (*Jellet*), or carbolic-alcohol 5 per cent (*Saul*). Chromicised gut may be treated in the same way. The iodine and boiling alcohol methods are the easiest, and are reliable. Catgut is usually stored in 90 per cent alcohol, to which a proportion (1-5) of glycerine may be added if the gut becomes too hard.

Sutures,—*silk* and *catgut*, are prepared as above, or *silkworm-gut* and *horse-hair* sterilised by boiling. *Silver wire* also is sometimes used, especially for suture of bone; it is prepared by boiling.

Sponges are made of bunches or folds of *gauze* or *sponge-cloth* (wick), or squares of thick "*Turkey towelling*"; any free edge with threads must be hemmed or the edge folded in. They are prepared by boiling for 15 minutes, and may be used directly out of that fluid, or transferred to an antiseptic lotion. They may also be sterilised by steam and used dry. For operations on the mouth or abdomen *natural sponges* are sometimes preferred, owing to their great powers of absorption. These are first cleansed thoroughly, and stored for seven days in frequently changed 1-20 carbolic. They should only be used once, unless the operation is quite "aseptic."

Towels are sterilised in steam, and those for the hands should be rough in texture. (In private, towels fresh from the wash may be used for the hands, as they are usually sterile in their inner folds.) Those used to surround the operation area may, in addition, be wrung out of an antiseptic lotion, and spread over mackintoshes. It is convenient to use for this purpose a sterilised sheet, with a window cut in the middle; it is spread over the patient, exposing no part but that immediately under the opening.

Dressings should be—1, aseptic; 2, absorbent; and 3, as a rule, antiseptic. The best absorbent is absorbent *gauze*, *i.e.* with all grease removed, used either plain or impregnated with iodoform or mercury salts; in any case it must be sterile

Wood wool, or cellulose wadding, are rather less absorbent, but cheap and efficient. Over that a thick layer of cotton wool is bandaged in place, to act as a cushion, and to filter the air which penetrates to the wound, in the same way as the plug of a bacteriological culture tube. When there is not likely to be any discharge, the wound may be sealed with collodion painted over a double thickness of gauze, and no further dressing applied. In abdominal cases it is better to support the walls with a binder. If adhesive plaster is employed for this purpose, only that prepared with zinc oxide should be used, or troublesome irritation of the skin may result. For operations in private, dressings, towels, aprons, etc. may be wrapped together in a layer of cotton wool, or a thick towel or canvas bag, before sterilising. They are carried to the operation in their packet, and not opened till the operation is just about to commence.

Drains of *rubber* or *glass tubing* or *decalcified bone* are used where there is likely to be accumulation of fluids, as in clearing out glands or in inflamed tissues. For small wounds *capillary* drains of horse-hair, silkworm-gut, or gauze, are often employed. Drainage by *gauze packing* must be frequently renewed, every 12-24 hours, as its capillary drainage powers are but slight.

Instruments are prepared by boiling (*vide* p. 74). Catheters should be of metal or rubber, and syringes of metal or glass, to be easily sterilised.

They may be used directly from the vessel they are sterilised in (the most reliable way); or be placed on sterilised towels and used dry; or plunged into an antiseptic lotion and used from that. This latter, though safe, is apt to cause much trouble from rusting of steel instruments, unless a sufficient amount of alkali be added to it.

After use all instruments should be plunged into a hot, strong (5 per cent) solution of soda, which partially cleanses them. They may remain in this for hours without fear of rust. After scrubbing with a brush they should be boiled in a fresh soda solution, rinsed in alcohol, and dried with a sterile towel, and stored in dust-proof glass jars or cabinets. Instruments which are rarely used may be greased with vaseline and wrapped in paper. Those in daily use, after scrubbing, may be stored in freshly boiled soda or borax solution; this saves time and labour in drying, and there is less liability of rust appearing, especially in scissors and other jointed instruments.

In private practice instruments are best placed in a metal box with a well-fitting but not water-tight lid,—knives being fitted into racks in a separate box,—and covered with a 2 per cent soda solution. The lid is closed, and the whole placed on a gas ring or spirit lamp, and boiled for 15 minutes. The box is then taken off the flame, and turned sideways to let the water run out *without opening* it. The instruments remain wet with soda solution, and may be safely kept in this way for many hours without rusting. They are then carried in their box to the operation and used directly from it.

Operation.—When all is prepared the patient is anæsthetised, and the part to be operated upon is finally washed with alcohol, to remove any loose epithelium. The area is surrounded with sterilised towels, leaving only a space open sufficiently large to allow the wound to be made.

The incisions must be clean, and all preventable tearing or crushing avoided. All bleeding must be stopped; the wound is dried, and sutured so as to leave no dead spaces, and the skin closed, grafting it if necessary from another part. All sponges, instruments, and ligatures should be handled by the surgeon only, and not passed from hand to hand. Sometimes it is necessary to have these handed by a nurse or assistant; but they should be picked up only with forceps, or with the hands protected by sterile gloves.

Closure of Wounds—

Wounds are closed by sewing together the edges of the skin, with straight or curved needles, held in the fingers, or in a holder. For skin suture they are furnished with a cutting point (Liston's, Hagedorn's), but for bowel suture, the ordinary round sewing needle is used, in order to avoid wounding of small vessels. For many purposes a needle fixed in a handle with an eye at the point is used, and this can be obtained with a sliding slot for opening the eye at will (Reverdin's), which is useful for sutures in deep situations, such as the vagina or palate, and for avoiding of unnecessary handling of the sutures.

Sutures may be *interrupted*, where each stitch is fixed separately with a reef or surgical knot. (Wire or silkworm-gut can be fixed with a double turn on a half-hitch.) These are always used when there is a probability of much effusion from the wound.

Continuous sutures are used in long incisions to save time, and in most cases for bowel suture. The thread is fixed at the beginning with a knot, and at the end with a turn round the last stitch.

When a wound is deep, closing of the skin alone is apt to leave "dead spaces" in which blood and serum collect. These must be prevented by suturing each layer—fascia to fascia, and muscle to muscle, etc. (*buried* sutures)—or by modifications of ordinary suture, as "button, mattress, quilted," and other stitches which have the object in view of bringing together the deep layers. When the peritoneum is opened, it is better to close it by a separate suture.

In any suture the rules must be observed, to approximate the edges carefully, so that one side does not overlap the other, and also that the skin is not dragged upon. Tension in the stitches leads to necrosis, and they soon cut their way out. Openings in a *bowel* are closed first with a suture which penetrates all the layers, and outside of this a line of suture which penetrates only the peritoneum and the muscular layer (*Lembert's* suture); in this way the cut edge is turned inwards towards the lumen of the bowel, while the peritoneal surfaces are rapidly glued together and seal the opening.

Ordinarily a suture is passed by picking up the edge with a toothed forceps, and plunging the needle perpendicularly into the skin about a quarter of an inch from its edge. If the needle is passed obliquely it penetrates with difficulty, and is apt to pucker the edges. The stitches are usually placed about a third of an inch apart.

Secondary sutures are used in cases where it is deemed inadvisable to close a wound at the end of an operation. Long sutures are put in place, but not tightened, and the wound is packed with antiseptic gauze. At the first dressing this is removed, and the sutures are then tightened. This enables the wound to be closed without incurring the extra pain of passing new stitches.

When a wound cannot be completely closed, the edges must be brought together as much as possible without too much tension, and the open parts covered with skin grafts, or allowed to granulate over.

The *materials* used are catgut, and chromic gut, tendons of reindeer and kangaroo (absorbable); and silk, silkworm-gut, horse-hair, celluloid thread, silver and aluminium-bronze wires (non-absorbable).

Other means of closing wounds are metal clips (Michel's); and gauze and collodion for "sealed dressing"; plasters are now discarded, for the most part, as dangerous when applied direct to a wound.

The dressings are taken direct from the container, and applied to the wound. After the operation it is better to prevent all movement for 48 hours, to lessen pain and aid healing, and for this purpose splints are often applied after operations on limbs.

After Treatment.—*Hypnotics.*—When there is much pain it is often advisable to give an injection of morphia, repeated, if necessary, once or twice in the first 24 hours. If the pain is still persistent it may be due to movement or to inflammation. For sleeplessness alone, it is better to give phenacetin or trional. If the patient is sick, sips of tea may be given in four hours; it will be comforting and may clear out the stomach. If there is no sickness, a cup of clear soup is given, and, later, milk, or coffee and milk. As soon as digestion is active, ordinary diet, not omitting vegetable food, should be resumed.

If a drain is used the dressings should be renewed in 48 hours; if the wound still discharges, it may be drained for another 48 hours. Undrained wounds may be left for three weeks, when they ought to be healed. Open sores should be dressed every 24 hours, and the dressing should be dry, or allowed to dry on the part, and not covered with waterproof.

The temperature and pulse should be noted; any rise of temperature occurring after 48 hours is suspicious of infection.

Antiseptic operations can be carried out efficiently in **private** houses if means be taken to prevent anything unsterilised coming in contact with the wound. The chief difficulty is with the air, and that, as has been pointed out, is of minor importance. But as it is a danger, no operations which involve long exposure of the wound, except those of emergency, should be undertaken, except in places where abundant precautions can be taken to eliminate avoidable contamination.

Certain operations must be done without delay, such as laparotomies for obstruction, or herniotomies for strangulation, or amputations after accidents, etc. For this purpose the surgeon ought to provide himself with (*a*) metal "containers" or stout linen bags, containing (1) several nail-brushes, (2) sponge-cloths, (3) thin towels and sheets, (4) aprons, all kept ready sterilised by steam; (*b*) a supply of turpentine, plenty of spirit; and mercury salts, and lysol, as antiseptics; (*c*) prepared catgut, silk, and silkworm-gut; (*d*) a large metal box, with a well-fitting cover, in which to boil and carry the instruments; and a nest of two or three metal trays for ligatures, lotions, etc. All other things are procurable in any house but the poorest. A large india-rubber bag for irrigation, with tubing and nozzle, which can be boiled together, and carried in a canvas bag, is often useful.

VARIETIES OF WOUNDS.

Incised, clean cut, such as are made by the knife, have sharp straight edges and flat smooth surfaces. (In wounds of the scalp and other places where the skin is directly above bone, the appearance may be that of an incised wound, though made with a blunt instrument.) The chief danger is from hæmorrhage.

Subcutaneous wounds, rupture of the structures beneath the skin. They are sometimes made by passing a narrow "tenotomy knife" under the skin and cutting downwards; since antisepsis has been introduced there is less reason to use this method. They may be made also by sharp blows on the skin.

Lacerated or torn wounds have irregular outlines, and usually bleed little, as the vessels are also torn. **Contused** wounds have considerable bruising of the deep parts, and often much extravasation of blood. These two arise from railway and other similar accidents, from explosions, or bites of animals. The chief dangers are septic complications arising from the entrance of splinters, etc. at the accident, or decomposition of blood-clot, with suppuration, sloughing, or tetanus. Dirt is apt to lodge in the pockets of torn flesh.

Gun-shot wounds are of this nature, and foreign bodies often enter with the projectile; when made by modern rifle bullets, they are of the nature of punctured wounds.

Punctured or stab wounds made by sharp-pointed instruments are deep and narrow, and their chief dangers lie in the possible puncture of a blood-vessel, or of the lungs, bowel, etc.

Treatment.—All such wounds except (1) those made under antiseptic precautions, or (2) subcutaneous, or small superficial incised and punctured wounds, should be regarded as infected, and treated as such. The wound itself is covered with a guard of sterile gauze, while the skin is cleansed up to the edge, as for operation (p. 77). The wound is then held open with retractors, and enlarged where necessary; it is well rubbed out with gauze, and flushed with sterile water or an unirritating antiseptic lotion. All bleeding is stopped, and foreign bodies removed, while loosely-attached or crushed tissues are cut off, and all pockets where blood or dirt might lodge are dried out. The wound is then packed with antiseptic gauze and left open, or closed with temporary (secondary) sutures. The packing is removed in three days, and if the wound is then found to be aseptic, the stitches are tightened or others put in. Where there is thick discharge the dressing may be applied moist, but should be frequently changed rather than kept damp with a waterproof covering. If the wound is clean cut and not likely to suppurate, it may be closed at once, with a drainage-tube left in for forty-eight hours or so. Only clean wounds in very vascular parts, where organisms are readily destroyed by the blood-supply, as in the tongue, lips, face, or ear, should be closed without drainage. Should a wound suppurate, it should be freely opened and treated as an abscess (*vide* p. 9). It may be flushed out with peroxide of hydrogen to remove pus cells and microbes; this lotion may be used also to loosen dressings which are sticking in a wound.

Rifle wounds and superficial punctures *occurring in war* may be treated *like* non-infected wounds, and covered with a "first field dressing," applied directly without any probing of the wound. The dressing is allowed to become soaked with the blood, and form an impermeable antiseptic cake in drying, the part being kept at rest to prevent excessive bleeding. To permit this the waterproof cover must *not* be applied. All other gun-shot wounds must be treated as above.

Foreign bodies,—bullets, needles, glass, etc. if they give rise to pain or loss of function, or threaten important structures with sharp edges, must be located by feeling, by X-rays, or telephone probe, and excised. If they do not set up irritation, they may be allowed to remain in the body.

BURNS AND SCALDS.

Burns are the effect of dry heat; **scalds,** of steam or hot liquids, affecting only the more superficial structures.

They are classed as follows (Dupuytren):—

1. Stage of *erythema*, with subsequent desquamation only.
2. *Vesiculation*, or raising of bullæ; with no scarring afterwards, but sometimes some pigmentation.
3. *Partial destruction* of the *true skin*, with islets of uninjured skin left. Healing by granulations, with subsequent scarring. These burns are very painful, as so many nerve-endings are involved.
4. Destruction of *whole skin*. Healing takes place by granulation, with much cicatricial contraction of the scars. As the nerve-endings are completely destroyed there is little pain.
5. Destruction of *skin*, *fascia*, and *muscles*.
6. Charring of *whole limbs*.

Constitutional Effects.—The chief is *shock* from irritation of so many nerve-endings in the skin. Children are specially affected, even after small burns. The face is pale, the skin cold and clammy, the pulse is weak and fluttering, the respiration rapid, and the pupils are dilated; there is coma, or delirium and restlessness, sometimes rigors, and in children convulsions. Internally the organs, especially the brain, are found to be congested.

If recovery takes place, reactionary *inflammatory fever* sets in, becoming established in 24-36 hours. This is due in part to absorption of the burnt tissue products, but more to the extensive local inflammation called out by the irritation to the skin. The pulse becomes full and rapid, the temperature rises, and other signs of fever appear. The dead parts slough, and are apt to decompose and to set up further septic intoxication. Inflammations of the internal organs are not uncommon, with pleurisy, pneumonitis, meningitis, etc. occurring as a result. (Duodenal ulcers are said to occur in this stage, and may be due to septic thrombosis of mesenteric veins following on absorption from the skin.)

Later, continued suppuration and sloughing may be established, with consequent *exhaustion* and hectic fever; destruction of large skin areas may cause subsequent deformities; or gangrene, lymphangitis, abscesses, cellulitis, erysipelas, or even tetanus may ensue. Albumen may be found in the urine, and is due to nephritis.

Treatment.—The constitutional effects must be treated first. Put the patient in bed with warm blankets, without disturbing the clothing over the burnt parts. Administer brandy by the mouth or rectum, and morphia to deaden pain, and prevent further shock. Saline infusion into the loose subcutaneous tissues or into a vein may be tried if the pulse is very small. Ether and strychnine may also be used.

When the patient reacts to these, the local injuries may be treated. For burns and scalds of the first and second degree, ointments are the most soothing. Carron oil may be used, as it keeps the skin cool by evaporating, but it is apt to decompose if used in deeper burns. Powders such as zinc oxide and bismuth are also cooling, and keep the part in good condition.

For burns which destroy any part of the true skin, ointments and antiseptics are dangerous, the one on account of sepsis which occurs beneath it, and the other from the danger of absorption of the poisonous drug. Picric acid in 5 per cent solution may be painted over shallow burns, as it forms a skin, and is to some extent antiseptic. Boric acid, as powder or in moist lint, is one of the best dressings, provided it be changed very frequently. The part may be treated with peroxide of hydrogen daily in addition. If the dressing causes pain an anæsthetic should be given, such as gas, or ethyl bromide or chloride. When granulations have formed, the part is treated as an open wound with aseptic dressing. All dead pieces of skin should be snipped off at each dressing as they die; and as soon as possible skin grafts are applied. Subsequent contraction of scars are treated by plastic operations.

Electric Shocks of very high potential either cause death, or give rise to asphyxia and stunning, usually with severe burns on the body. The **treatment** is artificial respiration and warmth, while stimulants are given if the patient is suffering from shock after respiration is established.

Lightning Stroke is usually fatal; but if not, the results are like those of a severe electric shock. There are generally superficial burns and signs of violence; and there may be permanent, central, or peripheral nervous lesions.

Treatment, as for electric shock.

Asphyxia is suffocation from immersion in water, breathing irrespirable gases, from pressure (hanging, strangling, or tumours) outside, and from foreign bodies inside the air passages.

Treatment.—Having removed the cause, proceed at once to artificial respiration, with warmth applied to the body and stimulation when breathing has returned.

CHAPTER V.

HÆMORRHAGE—SHOCK—DELIRIUM.

HÆMORRHAGE.

Arterial Hæmorrhage is distinguished by its red colour, except when the patient is partially asphyxiated, and its emission in jets; **venous**, by its dark purplish colour and its steady flow; **capillary** (parenchymatous), by its general oozing, with no visible bleeding points. Bleeding is freest from incised wounds, less so from lacerated or bruised wounds. **Primary** hæmorrhage is that occurring at the time of injury; **secondary** is recurrence from a vessel once closed. *Internal* hæmorrhage is bleeding into the cavities of the body; *hæmoptysis*, from the lungs; *hæmatemesis*, from the stomach; *epistaxis*, from the nose; *hæmaturia*, blood in the urine; *melæna*, in the fæces. *Extravasation* of blood is effusion into the loose areolar tissues; *hæmatoma*, a tumour formed by collection of such blood; *ecchymosis*, discoloration of the skin from subcutaneous extravasation.

Effects of Hæmorrhage.—When it is severe, and especially if rapid, death may ensue from *syncope*. In less severe cases (*collapse*) the face is pale, the lips are blanched, the skin is cold and wet with perspiration, the pulse is small and rapid, and disappears in the smaller vessels, respiration is sighing or gasping; there is faintness, vertigo, and dimness of vision, sometimes nausea and twitchings of muscles. These effects progress as long as the bleeding continues. Children bear loss of blood badly, as do also the aged. The loss of $\frac{1}{13}$ of the body-weight is usually fatal.

Repeated or *continued slight* hæmorrhages lead to *anæmia*, with shortness of breath, palpitations, waxy skin, œdema of the ankles and legs, headaches, and fainting fits.

Treatment.—In accidents, stop the bleeding by elevation of the limb and pressure either on the wound, with precautions against unnecessary contamination; or on the main artery with a tourniquet. Meanwhile treat the patient for syncope by laying him flat, with the head kept lower than the body, to favour the flow of blood to the brain and vasomotor centres. To aid this the four limbs may be raised perpendicularly, with elastic bandages lightly applied, while a binder is fastened firmly round the abdomen (*auto-transfusion*).

Warm blankets and hot bottles are applied to prevent chilling. Brandy, tea, soup, or other stimulants are administered by the mouth if the patient can swallow, if not, they are injected by the rectum. Ether, strychnine, ergot, or adrenalin may be injected subcutaneously to raise the blood pressure. Warm physiological *saline solution* (0·9 per cent) should be injected into the rectum (2-3 pints); or it may be *infused* hypodermically—a hollow needle, attached to a rubber tube and a funnel filled with the solution, is inserted into the loose tissue beneath the axilla or in the loin, and the fluid allowed to diffuse until 10 ounces or so are accumulated, the opening being closed with collodion as the needle is withdrawn. This may be repeated in other places, and diffusion and absorption helped by gentle massage; or in operations on the abdomen, the fluid may be poured into that cavity; or it may be infused into a vein, transfusion of blood being now discarded as dangerous, from risk of embolism. To carry this out a vein in the arm is exposed and cut across between two ligatures, the lower of which is tightened; a canula is substituted for the needle in the foregoing apparatus, and is inserted into the proximal end of the vein, while the ligature is temporarily tightened round it; 2-8 pints may be slowly injected, the funnel being raised only a foot above the vein, and the effect on the pulse noted meanwhile. Great care must be taken to prevent the entrance of air. The ligature is fastened as the canula is withdrawn, and the wound is closed. When saline is used for infusion it must be sterilised by boiling.

Arrest of Hæmorrhage—Natural.—When a small artery is cut, the end retracts into its sheath, and the walls draw together by contraction of the muscle fibres and the elastic tissue. The orifice being narrowed and the flow lessened, the blood becomes coagulated at its edges, owing to exposure to the air; the orifice is finally occluded, and the clot extends backwards into the vessel as far as its first lateral branch. The same process takes place in veins and capillaries, but with less help of muscular action. Permanent closure of the vessel takes place by inflammatory new formation replacing the clot and closing the end, which becomes covered over with endothelium; cicatrisation and contraction occur as in other situations.

Ice **cold** favours contraction of vessels and aids arrest of hæmorrhage. **Heat**, water at 120° F. is used to flush wounds with much capillary bleeding; it acts by stimulating muscular constriction of the vessel walls. **Cautery** points at dull red heat control bleeding by forming eschars with the blood and tissues; this method is used in vascular organs, mucous membranes, etc.

Styptics are rarely used, as they are useless unless they are applied direct to the ends of the vessels, when they may often be as well replaced by other means. Adrenal extracts (which are strong vaso-constrictors) applied locally, render a part bloodless for several hours, and are useful where Esmarch's method cannot be employed.

Surgical Methods.—Before an operation a limb is often made *bloodless* by applying a tourniquet, after elevating it for a few minutes; or less commonly after applying an elastic bandage (Esmarch); this prevents loss of blood and obscuring of the field of operation. Tourniquets are usually made of rubber—elastic webbing or stout tubing, fastened with a pin, knot, or forceps; or of a firm band, with a pad to place over the artery and a screw to tighten it.

The vessels met with during the operation are picked up with artery forceps, and *pressure* is applied with a sponge when the tourniquet is removed; any vessel not already stopped is caught with forceps. The forceps used are either pressure forceps with strong jaws, or artery forceps with rat-tooth points. Many of the vessels thus caught are found to be occluded when the forceps are removed at the end of the operation. If not, they may be stopped by torsion, *i.e.* twisting with a forceps till the end almost separates; this leaves a crushed and ragged end, which favours the formation of clot.

Other means of compression are by *angiotribes*, powerful crushing forceps actuated by screws or compound lever joints, —useful in controlling hæmorrhage in large masses, which are crushed to the thinness of paper (as in tumour-pedicles, piles, etc.); or long-bladed forceps applied to masses of tissue like the "broad ligament," and allowed to remain till they separate by necrosis in the course of some days. For capillary bleeding, especially in bone or solid organs, pressure is applied by packing the wound tightly with iodoform gauze and leaving it for two or three days.

The most usual method is *ligation*, by looping a ligature round the end of the vessel caught in the forceps, and tightening it while the forceps is gently loosened. This causes the inner and middle coats of the artery to rupture; and the torn edges to retract and curl inwards, and form a point of attachment to the clot which then occupies the blind end. The "surgeons'" knot is made by taking a double turn round the first hitch of a reef knot, to prevent it from slipping while the second hitch is made. Ordinarily a reef knot is sufficient. To tie an artery in *continuity* an aneurysm needle is used. This is a blunt needle, fixed in a handle with an eye at the point. It is threaded with a ligature and insinuated beneath the artery; the ligature is caught, and tied after withdrawal of the needle; or the empty needle is passed below the vessel, and threaded when it emerges. When a considerable amount of tissue has to be included with the vessel, it should be pierced with a needle, and the ligature carried round each half separately to prevent slipping. If a larger mass must be tied, a number of ligatures are passed by needles, and tied after interlocking the adjoining loops; pedicles are tied in this way, or by some form of "Staffordshire knot."

The material most commonly used for ligatures is catgut prepared in various ways; this becomes loosened in five or six days, and eventually absorbed; chromicised catgut lasts from 10-40 days. Those who do not trust the sterilisation of catgut generally employ boiled silk; but other threads may be used, especially the tough celluloid-hemp thread.

Reactionary Hæmorrhage is bleeding which occurs from failure of the temporary arrest, by loosening and washing away of the clots. It comes on when the patient has recovered from the shock of the operation or accident, the heart beats becoming stronger, and the warmth in bed tending to dilatation of the vessels. The causes are too great a vessel being left untied, or the slipping of an insecure ligature on movement of the part.

Signs.—The dressings are soaked through with blood, and in some cases there is faintness, with rapid and fluttering pulse.

In abdominal hæmorrhage of this kind there is, in addition, intense pain in the "pit of the stomach," and increasing dulness to percussion in the flanks.

Treatment.—When it occurs in limbs, and is not severe, additional padding and firm bandaging are usually sufficient to stop it. The blood dries into the dressing, and acts as a splint; it is better, however, to dress these cases in a few days, if it does not dry quickly. In severe cases the wound must be opened, and the artery caught and tied. This is especially necessary in abdominal cases. The danger of such accidents should be kept in mind, and all large abdominal arteries should be tied twice.

Secondary Hæmorrhage is the result of failure of permanent arrest. It appears from one to three weeks after operation; it may be seen in diffuse suppurations or abscesses.

Causes.—The chief one is septic infection which breaks down the external and internal clots; softens and loosens the ligatures; and causes sloughing of the closed ends, or of the vessel walls (*purulent arteritis*).

Other contributing causes (which, however, in absence of sepsis rarely cause secondary hæmorrhage) are—

1. Defects of ligation,—the ligature being too broad, or too loosely applied, so that the inner coats of the vessel are not divided, and inflammatory tissue does not readily form at the point of ligation; softening of the ligature material, and too rapid absorption. 2. Excess of blood pressure, as in Bright's disease. 3. Hæmophilia, with non-formation of clot. 4. Disease of the blood-vessels, such as tubercle and syphilis, in which the ligature cuts through. Atheroma and calcareous degeneration tend to weaken the walls, but alone do not usually give trouble after tying vessels.

Phenomena.—As the process of ulceration into the vessel is progressive, it usually begins with a small hæmorrhage, which soon stops by clotting of blood at the opening. This is repeated as the opening enlarges, until severe hæmorrhage suddenly occurs.

Treatment.—The bleeding must be stopped immediately, by pressure, with the hand or a tourniquet; and as the condition is progressive, the wound should be opened without delay. The bleeding end is sought for among the clots, while the pressure is relaxed; if the hæmorrhage has stopped meanwhile, the wound must be rubbed roughly to encourage it to bleed.

The bleeding end being caught in a forceps, the vessel is stripped up till a healthy part appears, and there tied again. The ulcerated end may be cut off, and the septic wound is carefully treated with antiseptic packing, frequently renewed. In an amputation stump, if the flaps are sloughing, it is better to do a reamputation at once. When an artery has previously been tied in continuity, it must be retied both above and below the bleeding point.

In some cases secondary ligature at the bleeding point is impossible; the following is the treatment:—

1. When the tissues are suppurating and friable, when there is parenchymatous oozing from numerous small vessels, or when the vessel lies deep out of reach; the bleeding is then to be stopped by firm plugging with antiseptic gauze, or by the cautery at a dull red heat.

2. When the vessel is more accessible just above the wound, it may be tied in continuity by means of a separate incision.

3. In some cases, where secondary ligature has been performed and gangrene is threatening, as in a limb, amputation should be proceeded with.

Hæmophilia is a condition in which there is a deficiency of the coagulating power of the blood. Severe bleeding is apt to occur from very slight injuries, which, in other persons, would give rise to none; or sometimes to start spontaneously in mucous membrane, or under the skin.

Pathology of this disease is as yet uncertain. Thinness of the vessel walls has been noticed in a few cases, and abnormality of the relative proportion of leucocytes. The disease, however, is hereditary, being transmitted almost solely by the female line, but affecting only the males.

Symptoms.—The hæmorrhage occurring after an injury (such as a tooth extraction) is severe and continuous, and is not easily controlled except by hard pressure on the spot; it may last for days.

Treatment.—*Prophylactic.*—When a patient is known to be the subject of this condition, no operations of any kind should be performed on him, except those of necessity. When *bleeding occurs,* rest should be enjoined, and a non-stimulating diet given. Pressure must be applied directly to the spot, and in mucous membranes adrenalin may be painted on, or perchloride of iron applied. Internally, calcium chloride (30 grains repeated every four hours) may be given; injections of gelatine have been tried to increase the coagulability of the blood.

SHOCK.

Shock is a condition of great lowering of the vital activity, showing itself chiefly in depression of the circulation. It is due to exhaustion of the medullary and cerebral centres, arising from general exhaustion, or from prolonged or severe stimulation of sensory or sympathetic nerves.

Causes.—1. Hæmorrhage, internal or external.
2. (*a*) Irritation of nerve-endings in the skin (burns), or nerve-trunks (crushes).
(*b*) Irritation of sympathetic nerves (abdominal injury or sepsis, etc.).
(*c*) Irritation of brain (injury to skull).
(*d*) Irritation of intellectual centres (excessive emotion).
3. General exhaustion, especially from cold, fatigue, starvation, etc.

Pathology.—Exhaustion of the nervous centres leads to loss of vaso-constrictor tone; from this follows dilatation of the vessels, especially of the splanchnic area. Here the blood collects ("bleeds into the veins"); less blood flows to the head, and further exhaustion of the centres ensues, and so on; the heart beat is weaker and the circulation diminishes.

Symptoms.—The face is pale, the skin cold and clammy, the muscles are relaxed, and the sphincters sometimes yield, resulting in discharge of urine, more rarely of fæces; respiration is shallow or sighing; the patient lies semi-conscious, but is easily roused; if questioned, he may complain of tinnitus or vertigo; if the pulse is felt at all, it is fluttering and weak, and the heart sounds are feeble and irregular; the temperature is lowered to 95°-98° F.; the eyes are lustreless, and the pupils widely dilated; thirst and nausea are often complained of.

The symptoms tend to progress till death ensues from coma, *or* reaction commences in 2-24 hours. In the latter case the pulse becomes slower and increases in strength, the face is flushed, and the skin warm and moist, the temperature rising to 100°-102° F. This reaction lasts from 12-48 hours or so. Excessive reaction (inflammatory fever) sometimes occurs after severe injuries, but is then due, not to reaction alone, but to septic absorption.

Treatment. — Keep the body recumbent, with the head lowered ; cover the patient with warm blankets, and apply hot-water bottles to the feet, the legs, and the sides of the chest ; rub the limbs vigorously, without too much exposure to cold air, in order to help the circulation. Brandy should be given in small doses (1 drachm in hot water), by the mouth : or if the patient is unconscious, in larger doses by the rectum, along with enemata of hot meat-extract, or even hot saline solution. If respiration is faint, it must be restored by artificial means. Pain should be relieved by injections of morphia ; when the pulse is found to improve, as a rule, if the shock is due to injury.

Strychnine $\frac{1}{60}$ grain, may be given hypodermically, and repeated four times in an hour. Saline solution may be infused into the loose tissues or into a vein. Digitalis and strophanthus may be given if there is continuous heart weakness. Adrenalin is found in many cases to raise the blood pressure and help the recovery from shock. In severe cases it should be injected continuously into a vein in warm saline solution in the dilution of 1 in 50,000. The blood pressure remains raised as long as the injection continues and for a short time after it is stopped. This effect is aided by "autotransfusion" methods ; and, if means are at hand, by general compression of the body surface by a pneumatic suit.

Collapse.—"The term is applied to cases of more sudden fall of the blood pressure from hæmorrhage, from injuries of the vasomotor centre, or from cardiac failure. The conditions represent suspension of function rather than exhaustion of centres. There being no exhaustion, stimulants and plain saline infusion may be of value." (Crile.)

DELIRIUM.

Delirium sometimes follows after injuries or operations.

1. Highly **nervous** patients may suffer, after simple injuries, from the effect of fright or shock. The delirium is usually low and muttering in character ; but it may become suddenly maniacal. The patient requires careful watching to prevent injury to self or others.

Treatment.—Rest and quiet ; hypnotics to encourage sleep —bromides, morphia, or chloral—with care that no depressing effect takes place in the already weak subject.

2. **Septic Delirium,** occurring three days or so after injury,

increasing as septic absorption reaches its height, and varying in intensity with the degree of fever.

Treatment.—Free drainage of the septic focus; attention to free movement of the bowels and action of the kidneys; morphia for sleeplessness, or chloral or phenacetin if pain is slight.

3. **Delirium Tremens** occurs in "alcoholics," sometimes after quite small injuries. The patient is restless, but less often violent. He suffers from sleeplessness, and tries to get out of bed. Delusions, of animals or devils watching him, are common, and to escape from these he is apt to jump out of the window; hence the need of continual watching of such cases. The eyes are bright and wakeful; the pulse is full and rapid, the tongue coated and tremulous; and the bowels are confined; the appetite is absent, and much coaxing is required to get the food swallowed; there is usually great thirst; the temperature is not abnormal as a rule; the hands tremble on being held out; there is muttering or continuous rambling talk.

Treatment.—Constant watching to prevent injury, with restraint when necessary. Frequent feeding with fluids or semi-solids, if necessary by the stomach tube passed by the mouth or nose. The bowels are kept open by small doses of calomel or other laxative. Morphia, bromides, or paraldehyde are given to favour sleep. *Alcohol* should not be given except in the case of aged or very weak patients.

CHAPTER VI.

ANÆSTHESIA.

The **General Anæsthetics** in use are—(1) chloroform and ether, and (2) nitrous oxide, and the chloride and bromide of ethyl. They are used either alone or combined, or mixed with oxygen, or in sequence. Short and slight operations may be done with the second class, and in cases where a general anæsthetic is deemed inadvisable, **local anæsthesia** may be employed; but for all other operations, ether or chloroform are more convenient both for the patient and the surgeon.

Whatever general anæsthetic is used the following **preparation** of the patient is advisable. The heart and the urine are examined beforehand, and any deviations from the normal are noted. Valvular disease of the heart need not preclude the use of a general anæsthetic if compensation is efficient; functional disturbances and inherent weakness are more dangerous, especially when due to fatty degeneration, which is often not diagnosed beforehand. If albuminuria, glycosuria, bronchitis or atheroma are present, ether should not be given, or only in small quantities, and chloroform only with great care. The bowels are cleared out with a purge, followed by an enema the night before the operation. The stomach must be empty or dangerous vomiting may occur. For this reason no food should be allowed for four hours before administration of an anæsthetic; but weak patients and children should not be left too long, certainly not over six hours, without some nourishment. Enemata of beef-tea or predigested food, with or without alcohol, may be administered half to one hour beforehand, or a cup of hot beef-tea may be given by the mouth about two hours before, when it will be absorbed before the anæsthesia is commenced. When there is dilatation of the stomach with retention of its contents, or when an operation must take place at once on a full stomach, it is better to wash it out. Generally the operation should be done in the morning, in order to interfere as little as possible with the habitual functions of the body.

If the patient can be kept in bed for forty-eight hours before, anaesthesia usually proceeds more quietly than when he suddenly ceases hard work and is placed under an anæsthetic at once, as in the case of accidents.

To prevent unnecessary shock, he must be kept warm with blankets and hot bottles, or a heated operating table.

In all cases the recumbent position should be maintained. Sometimes he must be placed in the lateral, the "lithotomy," or Trendelenburg's position (with the pelvis raised), when care should be taken that the neck is not bent or twisted, but kept always in the same straight line as the body.

All obstruction to free breathing must be removed,—constrictions of clothing about the neck, chest, and waist; all false teeth and other foreign bodies removed from the mouth.

Have ready at hand a gag and mouth-opener, a pair of tongue forceps; brandy, ether, strychnine, amyl nitrite, adrenalin, and apparatus for saline solution.

Effects produced by General Anæsthetics, especially Chloroform.

The **1st Stage** is one of excitement, and soon of inhibition of the intellectual and higher centres. There is partial unconsciousness and analgesia, when slight operations may be done, if no great irritation is expected. The reflexes, however, are all present, and are usually exaggerated, especially the conjunctival or corneal reflex (*i.e.* touching the conjunctiva which causes spasmodic closure of the eyelids); the pupils are usually dilated, but react to light; the pulse is strong and full, except in weakly or nervous patients; breathing is irregular and often "held."

An *intermediate* stage may be noted, varying in different patients, but specially marked in "alcoholics." There is crying, laughing, shouting, with struggling and rigidity, or spasms of the glottis, the masseters, and other muscles; the pupils contract slightly, and react less to light; respiration is quicker and deeper; the pulse becomes softer. Vomiting and retching are common at this stage, accompanied by faintness, stoppage of breathing, and dilated pupils; these may be averted by carefully pushing the anæsthetic so as to reach the next stage. These phenomena may be noted also on the patient returning to consciousness.

2nd Stage.—Inhibition of brain and spinal cord, with abolition of all reflexes, except the cardiac, respiratory, and in some persons the pudic. This is the stage of surgical anæsthesia or narcosis, and is similar in its phenomena to natural sleep.

There is muscular relaxation and loss of reflexes. The pupils are contracted, and do not respond to light; respiration is quiet and regular (except when the pudic nerves are stimulated, and then there is loud snoring or interruption of breathing); the pulse is soft (in chloroform anæsthesia, from fall of blood pressure, due partly to direct action on the heart, and partly to effect on the vasomotor centres); the patient is quite unconscious.

3rd Stage,—of danger, with inhibition of the medullary centres, and loss of cardiac and respiratory reflexes; preceded by relaxation of anal and urinary sphincters. The pupils are widely dilated, and the eyeballs soft and inelastic; respiration is shallow and intermittent; there is pallor or cyanosis. The radial pulse is weak or absent, and the heart sounds feeble; the body is cold, the skin moist, and there are general signs of collapse. If this is not rapidly recovered from, death ensues from stoppage of the heart.

Attention must be paid to the following points in administering chloroform:—

Respiration.—This should be heard, or felt with the finger, throughout. The breathing should be soft and regular. *Note*, that in operations on the anus, urethra, or wherever the pudic nerve is stimulated, the breathing takes on a typical character, often spoken of as "rectal" breathing. At the same time the pupils are usually dilated, or at least irregularly contracted.

Colour.—Cyanosis is due to interference with respiration, either from mechanical or physiological causes; pallor implies depression of the circulation due to surgical shock, impending vomiting, or overdose of chloroform.

Corneal Reflex.—Loss of this is one of the first signs of commencing anæsthesia, but if still present is a positive sign that the patient is not "under." It is sometimes abolished by the local effect of chloroform vapour, and it is not a reliable index of anæsthesia.

Pupil.—In the first stages it is of no use as a guide, being widely dilated or contracted, but nearly always sensitive to light. In deep narcosis it is well contracted and insensitive to light. In intermediate stages it is sometimes widely dilated and insensitive to light, if the patient is about to vomit, but it contracts and reacts to light as soon as the sickness passes off. In the dangerous collapse stage it is also dilated. In *rare* cases it is dilated throughout full anæsthesia.

Muscular System.—Struggling occurs in early stages. Reflexes are abolished and muscles relaxed in full anæsthesia. The reflex contraction of abdominal muscles is sometimes late in disappearing, even with extreme narcosis.

Pulse.—At first it is often rapid, especially when there is struggling; then weaker and slower in full anæsthesia. The addition of a little ether, or injection of saline, rapidly increases the strength of the pulse for a short time.

Difficulties of anæsthesia.

(*a*) **Respiratory** are the most important, and are due to—

Mechanical obstruction. The *lips* of toothless persons are often closed. The *tongue* may be drawn back by muscular spasm, or may fall back on to the pharyngeal wall when the muscular system is relaxed. Enlarged tonsils aggravate this danger. *Treatment.*—Open the mouth and pull forward the tongue, or turn the head sideways.

Mucus, blood, or vomited matter may enter the *throat.* This must be prevented by keeping the head low, or by frequent swabbing out with a sponge on a holder.

False teeth or other *foreign bodies* in the mouth; these must be sought for and removed in each case before beginning anæsthesia. Tight clothing about the neck, waist, or chest must be loosened. The neck may be bent on the body in certain positions; see that the head is kept in line with the body.

Spasm of the *glottis* with stridor may occur, and is often reflex, from concentrated vapour. *Treatment.*—Give plenty of air.

In any case of obstruction—

1. Pull up the chin, to straighten out the line of the air passage, or

2. Push forward the jaw, and with it the root of the tongue.

3. Open the mouth, and pull forward the tongue with forceps.

4. Make rhythmical traction on the tongue at intervals of four seconds.

5. In all cases where these means do not quickly restore breathing, proceed at once to artificial respiration. The most convenient method in surgical practice is Howard's direct method, by intermittent pressure on the lower ribs, and in thin persons, dragging them open at their margins; or if the patient is prone, Schäfer's method, with similar pressure in that position; Sylvester's method also may be used. Slapping the chest with a cold wet towel often restarts breathing.

6. If the obstruction is from foreign bodies in the throat, tracheotomy must be performed when they cannot be extracted at once.

Paralysis of respiratory centres, occurring usually from an overdose, and then always accompanied by a very weak pulse and pallor. *Treatment.*—Artificial respiration.

(*b*) **Circulatory.**—Nearly always associated with respiratory difficulties.

Predisposing causes—exhaustion, impaired cardiac action, fear.

Exciting causes—surgical procedure, asphyxial conditions, toxic doses of chloroform, vomiting.

Treatment.—First see to the *respiration.* Keep the head low, by raising the end of the table if there is dangerous failure of the heart; or in children, by holding them up by the legs. Wet the lips with diluted brandy. Add a few drops of ether with the chloroform. Infuse saline solution into the subcutaneous tissue, or in severe heart failure, into a vein. Inhalations of amyl nitrite may be employed.[1] Injection of ether should only be used if the patient is not deeply under the anæsthetic, otherwise it is only increasing the narcosis. Injections of strychnine or brandy are of little use unless used *early*, when the blood stream can carry them away. Electric stimulation, of such kind as can be used in the circumstances, is held to be of no value. Mustard plasters, or hot cloths applied over the heart area, are also of little use in severe heart failure.

After-Effects.—Recovery takes place in the inverse order of "going under"; it varies in rapidity, being quick after short anæsthesias, and slow after long ones. The anæsthetist should never leave the patient till signs of consciousness have been shown; and no opiate should be administered while the patient is still unconscious.

Nausea and Vomiting follow in about two-thirds of the cases, but only a third suffer, as a rule, for more than four hours. Slight sickness is perhaps more common after ether, but it is apt to be more severe after chloroform. It nearly always occurs if there is food in the stomach at the time of the operation; and it is often excited by moving the patient while he is recovering from anæsthesia.

Treatment.—In slight cases, rest, quiet, and no food for four hours, then a cup of soup or tea. In severe cases, sips of hot tea or coffee, or draughts of the same, to promote vomiting and so clear the stomach; or lavage with warm water and a little soda bicarbonate. Champagne or soda water sometimes help to allay vomiting.

Bronchitis or **Broncho-Pneumonia** is sometimes set up by the irritant vapour, especially of ether, rarely of chloroform. Pneumonia can be caused, however, by inhalation of blood or vomited matter during an operation. **Congestion** of the **kidneys** and of the **brain** have been noted after ether.

Paralysis of the muscles of the arm has been caused by faulty position of the arms—hanging over the edge of the table, or stretched above the head, with continued pressure on one of the branches of the brachial plexus.

Special Anæsthetics

Chloroform is most generally useful, being more portable than ether, and also available in hot climates, where the latter cannot be used conveniently. It is, however, four times more dangerous than ether, from its depressing effect on the circulation, the border between the limits of safety and danger being narrow.

It is administered always by the **open** method, either on a *folded towel*, or on lint or gauze set in a wire frame (*Skinner's mask*, or Schimmelbusch's modification); or on *Allis's inhaler* (a frame holding many plies of bandage, moistened with chloroform, between which the air passes); or *Junker's* inhaler (in which air is pumped through a two-necked bottle on to an open face-piece, or through a tube placed in the naso-pharynx during operations on the nose or throat); or *Harcourt's* (with a bottle somewhat similar, but differing in detail, and actuated by the patient's inhalations); or *Roth's* apparatus for the administration of chloroform with oxygen, both in measured quantities.

When a mask is used a few minims are dropped on it, to allow the patient to become accustomed to the fumes. He should have his eyes closed, and be asked to count out loud; this ensures that respiration goes on as long as he is conscious. In children the same result is got by the usual crying. The dose is increased gradually as the larynx becomes accustomed to the vapour.

(Experiments show that the vapour should never be more than 4 per cent of chloroform; and 2 per cent is usually sufficient to maintain anæsthesia, when once it has been reached.) Too strong a vapour at first causes struggling, rigidity, and suspended breathing; too weak, causes delay and imperfect anæsthesia, with pallor, feeble pulse, and vomiting.

Ether is rarely administered by the open method, except as an addition to chloroform, or for producing analgesia for small and short operations. It is almost impossible to get an adult patient under the full influence by this means. It may be given by the **semi-open** method, by using Rendle's mask (a cone-shaped mask holding a sponge which is moistened with ether), or Allis's inhaler with a cover to the open end, or wire frames covered with gauze, and on the outside of this a layer of waterproof. These are all efficient if used with skill, but they require a large quantity of ether owing to the amount of air admitted. The **closed** method by Clover's (regulating) and Ormsby's inhalers is the most satisfactory way. In these a rubber bag is attached to a well-fitting face-piece into which the patient breathes and rebreathes his own breath, which takes up a little ether vapour each time from a reservoir as it passes. Either of these instruments is safe, efficient, and convenient.

The **effects** of ether are similar to those of chloroform, with certain differences. In the first stage there is apt to be more spasm of the glottis from the irritating vapour. In the second stage there is usually a greater secretion of mucus in the respiratory tract; hence the throat must be swabbed out more often. There is less depression, however, of the circulation, and the pulse is full, and breathing is freer. In this stage also the pupils are only moderately contracted, and are often reactive to light. The danger zone with ether is much wider than with chloroform, *i.e.* there is much greater warning given of any untoward occurrence.

Mixtures of chloroform and ether are occasionally used to obtain the stimulating effect of ether; or chloroform and oxygen, using the Roth-Draeger apparatus. A.C.E. mixture = alcohol (1), chloroform (2), ether (3 parts).

Certain **sequences** are used also,—ether preceded by nitrous oxide, or by ethyl bromide, or ethyl chloride.

Ethyl bromide is used on a small waterproof-covered mask, by pouring on a drachm or two (10-20 grm.); and ethyl chloride is sprayed on to a piece of wool in a similar inhaler; or either may be used in an Ormsby's inhaler. Anæsthesia usually ensues in 60 seconds, and lasts for two or three minutes. If it is not maintained for more than this time, nausea is very exceptional, and the patient wakes at once, and after a short rest may be allowed to go away. They are only useful for short operations, but for such are very useful.

Nitrous Oxide is administered for similar purposes, from a cylinder in which it is compressed; it is used alone, or with the addition of oxygen when a continued anæsthesia must be maintained. A tube, with an intermediate rubber reservoir, leads to a well-fitting face-piece furnished with valves to admit air or gas at will. The patient breathes air alone at first, and gas is admitted gradually till it is given pure. As anæsthesia ensues the face becomes congested and even cyanosed; the breathing is rapid and somewhat stertorous; the muscles are flaccid, or in tonic or clonic spasm; the pulse, at first full, becomes quicker and softer; the pupils are dilated, but the conjunctiva is usually sensitive. The anæsthesia, though light, remains for 15-45 seconds. After a single administration the patient wakens without ill effects. Faintness or sickness are rare, and are usually due to the presence of food in the stomach.

A newer general anæsthetic is **Scopolamine**, of which $\frac{1}{50}$ grain is injected subcutaneously along with $\frac{1}{5}$ grain of morphine in 20 minims of water. This is given four hours before the operation, and repeated after two hours, and again the next hour. The first injection sends the patient into a deep natural sleep in half an hour or so; the second intensifies this, and the reflexes are diminished, the respirations are slowed, but the pulse is accelerated. The third increases the anæsthetic effect; but there is not complete relaxation of the limbs, and any violent disturbance, loud noises, or bright light may waken the patient. The sleep lasts for four or five hours, during which operations can be performed without the patient suffering or feeling anything, and he wakens free from pain and nausea. There is considerable dilatation of the superficial vessels, and this may lead to excessive bleeding; and the persistence of muscular reflexes causes some difficulty in operations on the abdomen. With these exceptions scopolamine seems to possess many advantages, though recent experiences have shown that it is by no means devoid of danger. If the anæsthesia is not complete a small quantity of chloroform should be administered.

Local Anæsthesia can be produced by *cold*, by applying ice and salt mixture to the part, or by spraying it with ether or ethyl chloride. Considerable pain is felt as thawing occurs, and the process is of limited application. A certain amount of anæsthesia is produced by rendering the part *bloodless*, and this is used to intensify that produced by other methods. More efficient means are found in cocaine and similar drugs. **Cocaine** hydrochloride in watery solution of 5-10 per cent is used as an application to mucous membranes with a brush or spray, or in 1 per cent solution dropped into the eye. A more lasting effect is got by dissolving the salt in vaseline or paroleine. *B. eucaine* is less toxic than cocaine, but weaker and slower in acting; the hydrochloride or the more soluble lactate are generally used. *Tropacocaine* and *stovaine* have similar properties, and *holocaine* is useful for external application. When applied to the surface of the skin cocaine has no penetrative effect, and for this reason it must be injected. The tympanic membrane, however, which has a covering of cuticle, can be anæsthetised by painting it with a solution in aniline oil. The maximum dose of cocaine is $\frac{2}{3}$ of a grain, while that of eucaine is as much as 3 grains. Poisoning causes symptoms of heart failure, with cyanosis, faintness, palpitations, tinnitus, and vertigo.

For small areas or for tooth extraction it may be used *hypodermically* in 1 per cent solution. For larger areas it is *infiltrated* into the skin (*Schleich's method*), in weak solutions, usually 0·1 per cent in physiological saline solution warmed to body temperature. It acts almost at once, and incisions can be made into the skin without causing pain, while the deeper layers are by nature very insensitive. This method is extensively used for operations on the thyroid gland.

When injected into a finger or toe, the application of a tourniquet greatly increases its activity by preventing the solution from being washed away in the blood stream. (*Oberst.*)

The injection of suprarenal extract either along with or before the cocaine causes a local ischæmia (*Braun*). This acts in the same way as a tourniquet in regions where that cannot be applied, and prevents the solution from being carried away. The effects are much increased, and extensive operations can thus be performed when a general anæsthetic is inadmissible. The solution is made by adding 3 grains of eucaine hydrochloride to 3½ ounces of saline, and, after boiling to sterilise it, adding 15 minims of a 1-1000 adrenalin solution. This solution is injected into the skin, which must be prepared for operation. It does not take effect for nearly half an hour, and then anæsthesia lasts for some hours. The part is whitened by the ischæmia produced.

Regionary Anæsthesia is obtained by injecting a 1 per cent solution into a nerve (*Cushing*); or into a nerve-sheath (*Corning*). The parts supplied by the nerve become anæsthetic, as all the impulses are cut off.

A further development of regionary anæsthesia has been introduced by *Bier*, by injecting cocaine or eucaine into the arachnoid space of the *spinal cord.* The anæsthesia produced in this way extends from a little above the point of injection, *i.e.* the fourth lumbar interspace, to the feet. Operations may be conducted on the legs or the rectum, and in the groin. The anæsthesia is complete, but the after-effects are so dangerous and unpleasant that this method in its simple form is not to be recommended. Tropacocaine has been used, or the eucaine has been dissolved in the cerebro-spinal fluid which escapes at the puncture, without much improvement in the results. The addition of *adrenalin*, however, is found to limit the spread up the arachnoid space and the rate of absorption of the drug; and Bier reports many cases where no dangerous symptoms have appeared, and where the effects have been much less disagreeable. The substitution of stovaine for eucaine also seems to be an improvement.

SECTION II.

SURGERY OF SPECIAL TISSUES.

CHAPTER I.

INJURIES AND DISEASES OF BLOOD-VESSELS.

INJURIES TO BLOOD-VESSELS.

Contusions to arteries have, as a rule, little effect, unless partial rupture takes place.

Rupture of Arteries is due to injury against bones, from crushes, or fractures, or from violent stretching in cases of dislocation, or straightening a stiffened joint.

Partial Rupture; in this the internal and middle coats are torn, but the external remains. This may be distended to form an aneurysm; or the inner coats may be curled up in the lumen, and so block the channel, cutting off the circulation below; or the external coat may rupture from the pressure of the blood stream.

Complete Rupture is when all the vessel coats are severed. The blood flows out into the soft structures, causing a swelling which steadily increases in size, sometimes with pulsation and thrill. This presses on the veins and lymphatics, causing engorgement and œdema. The pulse below the injury is imperceptible, and in rupture of a main artery, the limb becomes cold and livid, and gangrene is very apt to occur. There is usually pain at the point of injury, and often in the rest of the limb. In severe cases there are constitutional signs of hæmorrhage.

Treatment, when the circulation is cut off, must be directed to favour collateral circulation; the limb must be kept warm, and raised to aid venous return. The skin should be prepared antiseptically as for an operation. If blood is extravasated in quantity to form a hæmatoma, an incision should be made, the clots turned out, and the ends of the vessel, if visible, tied above and below. In the case of a main vessel, an attempt may be made to join the ends by suture to avoid the possibility of gangrene. This may be done more easily by inserting a canula of pure magnesium, which ultimately undergoes absorption (*Payr*). Should gangrene occur, the limb must be amputated as soon as a line of demarcation appears. In crushed limbs, suppuration, with subsequent secondary hæmorrhage, is apt to occur, and must be guarded against.

Wounds of Arteries may arise from stabs, or gunshot wounds from modern rifles.

Non-penetrating wounds usually heal well, but the scar may rupture or become the site of an aneurysm.

Penetrating.—The effects depend on the direction of the cut; if longitudinal, it tends to close spontaneously; but if transverse, the wound is dragged apart by the retraction of the vessel wall, and a gaping oval opening is left. In the first case little hæmorrhage takes place, but a scar is formed with tendency to aneurysm formation as above; while in the second, bleeding is profuse. If the *great vessels* are wounded, death usually rapidly results; small vessels, if cut across, usually stop bleeding spontaneously. Medium vessels bleed profusely until syncope relieves the pressure, and allows the formation of clot. This may be washed away on recovery of the heart's power, and bleeding is repeated.

Treatment.—While the bleeding is controlled by pressure, the ends of the spouting arteries are caught in forceps and tied. If a punctured artery is exposed in continuity, cut it across and tie each end. Lateral wounds in large arteries may be sutured with fine needles. If the bleeding is stopped, and the arteries not visible, the wound should be packed with antiseptic gauze for 48 hours. If bleeding recommences, expose the vessels by dissection and tie the ends. All obstruction to collateral circulation must be removed. In places where the vessel is inaccessible the main artery may be tied, *e.g.* the carotid, in wounds of the mouth, etc., or amputation of a limb may be required.

If *secondary* hæmorrhage occurs, it must be treated as on page 93.

Wounds of Veins, when small, may be stopped by pressure. They tend to heal rapidly, as there is little pressure of blood, and the edges are not drawn apart. In large wounds the clot may be so large that the lumen is obliterated. In transverse division of veins the walls collapse, and clot forms between the first valve and the next branch, while the end heals as in an artery.

Treatment.—Pressure, as a rule, is sufficient; but puncture in a large vein may give rise to profuse hæmorrhage. The opening should be sutured if possible; or a *lateral* ligature should be applied to stop the bleeding without closing the lumen. If this cannot be done the vein must be cut across between two ligatures.

Dangers.—Apart from the possibility of subsequent phlebitis, with thrombosis and embolism, there is a special danger of **air entering** a large vein during an operation in the region of the neck or axilla. The suction of the thorax in inspiration is apt to draw air in if a vein is open. The symptoms come on suddenly, with but little warning from the hissing noise when air enters a vein. There is sudden collapse, with dyspnœa and syncope. The effects are produced by the air forming a froth with the blood, and blocking the capillary vessels of the lungs, with consequent straining of the right ventricle, while the left is unfilled.

Treatment.—Immediate pressure on the part; lower the head to encourage the vein to bleed, and also to supply an extra amount of blood to the brain. Pick up, and tie the vein; and *afterwards* proceed to artificial respiration, along with stimulation by brandy, ether, and infusion of saline. Oxygen for inhalation should be given if available.

Wounds of an artery and vein made simultaneously may lead to the formation of *arterio-venous aneurysms* (*q.v.*).

DISEASES OF BLOOD-VESSELS.

Acute Arteritis occurs in process of repair of the walls, after ligation, etc.; and in an infective form as a result of sepsis, from infective embolism, or from external sources. The walls soften, and may give way, leading to so-called secondary hæmorrhage. The effect of arteritis is to set up thrombosis in the diseased artery.

Chronic Arteritis is much more common, being the antecedent to **atheroma.** It affects chiefly the deep layers of the tunica intima, while the outer two are little affected. It is found principally in the larger vessels, and especially where pressure effects are felt—at the bends and bifurcations of arteries.

Causes—(*a*) *vascular pressure,* from (1) strain, (2) abuse of alcohol, (3) Bright's disease, (4) plethora; (*b*) *degeneration* of vessels, from (5) syphilis, (6) gout, (7) old age.

Pathology.—Patches of inflammatory round-cell infiltration appear in the deeper layer of the tunica intima, next to the internal muscular coat. These give rise to scattered, greyish, elevated, but soft areas. They undergo fatty degeneration; or, at a later stage, calcareous (secondary), or rarely, fibrous infiltration.

Fatty Degeneration leads to softening, and sometimes to ulceration (*athèromatous ulcer*). This causes weakening of the walls, and a fusiform or dissecting aneurysm may form; more rarely, the atheromatous material is washed away and causes embolism in the smaller vessels.

Calcareous Infiltration takes place with formation of chalky plaques. If the tunica intima over these is destroyed, they are apt to be carried away as emboli, leaving behind a weak point, which also may be the starting-point of an aneurysm.

Fibrous Degeneration, with thickening of the vessel walls, sometimes occurs. This may lead to narrowing of the lumen, with injurious effects on the part supplied.

Syphilitic Arteritis is found commonly in the smaller arteries of syphilitic patients. The whole inner coat is thickened, with round-cell infiltration, affecting all the circumference, which goes on to fibrous formation. The calibre is, in consequence, much diminished, and the parts supplied suffer accordingly. The tunica adventitia is often thickened as well. Thrombosis or aneurysm may occur, and in the brain softening is often the result.

Endarteritis Obliterans is a thickening of the endothelial and subendothelial layers of the smaller arteries, especially those of the brain. It is not uncommon among those suffering from syphilis, but there is no proof that it is specially dependent on it. The process goes on till the lumen of the vessel is obliterated, and leads to gradual diminution and final stoppage of the blood-supply. When it occurs in the brain it results in cerebral degeneration. In limbs it is characterised by pain along the line of the artery, with coldness and lividity of the parts supplied.

Tubercular Arteritis, or more correctly *tuberculosis of the tunica intima* of arterioles, is found in spots of tubercular new-formation (*miliary tubercles*). The vessels become infected by tubercular emboli, which are arrested in the arterioles. The tumour grows, and fills up the lumen of the vessel, and bursts through its walls, forming, indeed, the miliary tubercle.

Primary Degenerations.—*Fatty Degeneration*, in which the tunica intima is affected, is sometimes met with, but it gives rise to no special effects.

Calcareous Degeneration (*arterio-sclerosis*) is met with commonly as a primary affection. It begins with calcification of the muscular fibres of the middle coat, usually in rings, and fairly uniform. The arteries become rigid and often tortuous, and pulsation is obscured by the hardness of the vessel walls. The tendency is not towards aneurysm so much as to thrombosis, with gangrene of the part supplied, on account of the unregulated and diminished blood-supply.

Embolism is plugging of a vessel by a solid body, usually a clot or a piece of fibrin, from the heart, or a thrombosed vein (less commonly by fat globules, or air-bells). The effect is to cut off the blood-supply. If collateral circulation is not established it causes *infarction* in the lungs, kidneys, or liver, etc.; in a limb, gangrene; and in the brain, softening.

Septic Emboli set up secondary abscesses wherever they lodge.

Metastatic Emboli, conveying cells from malignant tumours, set up secondary tumours where they are arrested.

Aneurysm

An **Aneurysm** is a blood tumour communicating with an artery. Aneurysms are divided into *traumatic* and *spontaneous*.

A **Traumatic Aneurysm** is formed by (1) rupture; (2) a lateral wound; or (3) incomplete closure after division of an artery. It becomes *circumscribed* when the blood flows out to form a hæmatoma, and, if the pressure is not too great, inflammatory thickening occurs round it, making a capsule of fibrous tissue. Meanwhile, layers of fibrous clot are deposited on the walls of its sac, till it differs little from the later stages of a spontaneous aneurysm. From the weak nature of its walls, however, there is danger of it bursting in the early stages.

Diffuse traumatic aneurysm is a rapidly growing swelling, formed by diffusion of blood into the soft tissues near a ruptured artery, with pulsation and pressure effects in the neighbourhood. The extent of the swelling is limited only by the amount of distension possible in the parts.

Diagnosis *of diffuse aneurysm* from spreading suppurations, etc., is made from the history of injury; the rapidity of appearance of the swelling; its pulsation, and sometimes "bruit"; loss of pulse below the swelling; and presence of numbness and œdema, and the absence of fever.

Treatment, as for ruptured artery.

Spontaneous Aneurysm occurs from distension of the walls of an artery as a result of weakening by disease.

Cause.—Among the *predisposing* causes are—(1) Atheroma (*chronic arteritis*) and its contributing causes, especially syphilis and old age; it is more prevalent amongst males. (2) *Embolic arteritis*, from whatever cause, also causes weakening of the walls above the blockage.

The *exciting* causes are—(1) injury to the artery; (2) increased internal pressure, from (*a*) increased heart's action, and (*b*) obstruction beyond the point of origin of the aneurysm.

Varieties.—When an artery yields to pressure from within, its walls may be distended and elongated uniformly at one point, forming a **fusiform aneurysm**. The three coats form the sac; the muscular coat being thinned out, while the inner one is thickened by atheromatous or calcareous plates, and the external by fibrous inflammatory tissue.

When dilatation occurs in part only of the circumference a **sacculated aneurysm** is produced. Here all three coats may be present, but the inner coats usually give way, and the sac is formed by the external coat only.

Dissecting aneurysm is one where the internal and part of the middle coats are separated from the outer wall, and the blood forces its way between the layers.

Those distinctions are to be made out only in the early stages, as, later, the parts are much disturbed by pressure, by inflammatory thickenings and new-formation, and by deposits of laminated clots.

Progress.—Spontaneous **cure** may take place by (1) gradual deposit of fibrin on the walls, in layers, until the whole lumen is closed; (2) by filling up with coagulum, which becomes organised, as in other parts; or (3) by infiltration of fibrous tissue, from inflammatory thickening of the walls, followed by cicatrisation and contraction. These effects are encouraged by any circumstances which weaken the pressure or current of blood in the aneurysm, (*a*) by lowering the heart's action; (*b*) diminution of the fluid part of the blood; (*c*) obstruction to the blood stream above or below the aneurysm, from pressure of the tumour itself, or of effused blood outside; or from plugging of the efferent artery inside by clot, or rupture of the afferent artery, and spontaneous arrest of its hæmorrhage.

Rupture may occur in the sac, from injury, ulceration, or sloughing, with fatal hæmorrhage, or with oozing, and extravasation into the soft tissues. Or gangrene of the limb may set in; or in large internal aneurysms, general constitutional disturbances, especially from pressure effects. Suppuration, though uncommon, may take place, usually with fatal results.

Pressure of the aneurysmal sac outwards causes

(1) Inflammatory infiltration and thickening round it. This, after a time, becomes so great in proportion to the real sac walls that it virtually takes their place.

(2) Pressure on the adjacent veins, with engorgement and œdema.

(3) Irritation, or destruction of nerves, leading to pain or paralysis.

(4) Erosion of subjacent structures—bone, trachea, œsophagus, etc., causing obstruction, ulceration, etc.

Signs and symptoms of external aneurysm.

The earliest is pain, often mistaken for rheumatism; then stiffness and weakness of the limb, and if near a joint, impaired movement. A swelling is felt in the line of the artery, pulsating with each systole of the heart, and expansile in all directions from its centre. The pulse in the artery below the aneurysm is delayed and diminished in strength, when compared with the corresponding artery of the opposite side; and a pulse-tracing shows an absence of the dicrotic notch. Raising the limb lowers the blood pressure, and diminishes the size and pulsation of the tumour. Pressure on the artery above the tumour affects this still more, or abolishes pulsation altogether: pulsation returns gradually, however, when pressure is removed. On auscultation a loud "bruit" is usually heard. The heart, in cases where a large aneurysm is situated near by, shows signs of compensatory hypertrophy. Pressure on the surrounding tissues gives rise to pain or paralysis along the line of nerves ; to distension of veins and œdema ; to gangrene ; or to embolism. When bone is eroded, fracture may take place.

In *internal aneurysms* the tumour is seldom to be felt, and the only signs available for purposes of diagnosis are those of pressure on systemic or sympathetic nerves, and on the heart or blood-vessels.

If an aneurysm undergoes cure, it becomes harder in consistence and smaller. Pulsation becomes less marked, and finally disappears when the sac is filled with clot. Pressure effects, however, last for a long time, and may be permanent.

If rupture takes place, there is faintness and other signs of hæmorrhage. Death usually occurs rapidly if it takes place externally, or into a cavity of the body. Hæmoptysis results when rupture occurs in the respiratory tract, and hæmatemesis when in the stomach or œsophagus. If gradual leakage takes place, the tumour becomes larger and less definite in its limits, and a "diffuse aneurysm" may form, with increased pressure effects.

Diagnosis.—(1) From chronic abscess or other soft tumour, which has pulsation transmitted from an artery lying beneath it:—the pulsation, however, is not expansile ; the size does not diminish when pressure is applied to the artery, and the pulsations return at once in full when this is relaxed ; the pulse below the tumour is not delayed or diminished.

(2) From pulsating sarcoma or nævus :—pulsation is less forcible ; the limits of the tumour are not well marked ; bruit is absent ; and the pulse below the swelling is not affected.

(3) From neuralgia :—the tumour is absent, and there are no pressure symptoms.

Treatment—General.—In many internal aneurysms this is the only method possible, and in all cases it should be used in addition to any local treatment. It consists of complete rest in bed, with absence of all worry or excitement, in order to diminish the heart's action. Diet must be light and unstimulating, with a restricted quantity of fluid (avoiding all extreme "diets," which are too lowering to the vitality). The bowels must be moved freely every day, but without purging.

Drugs, such as potassium iodide, especially in syphilitic cases, may diminish vascular tension. In feeble patients iron tonics may be given. Calcium chloride in 30-grain doses three times a day may increase the coagulability of the blood; while the same result is got by hypodermic injections of gelatine solution (25 grains in 5 ounces saline solution sterilised in an autoclave).

Local.—All surgical methods in use have as an object the obliteration of the aneurysm, with part of the artery in which it is situated, either by extirpation, or by filling with *organised clot*. This latter may be encouraged by compression, by ligation, or by irritation of the interior.

I. **Compression** above, below, or all over the aneurysm; it may be intermittent (30 minutes or so at a time), or continuous (3-12 hours or more); it may be complete, or incomplete. It may be maintained by pressure of the *thumbs* of a relay of dressers. (This is the best way, where it is available, as pressure can be more carefully adjusted; but it is difficult and wearisome to carry out, and requires skill and care.) To relieve part of the strain on the hands, a bag of shot or a *weight* may be substituted, and kept in position over the vessel by the fingers. A variety of *tourniquets* have been devised for prolonged pressure, the best of these being provided with a *pad* and adjusted with screws. Another method of pressure applicable to aneurysms in the popliteal space and the bend of the elbow is forced *flexion*, by binding the limb in position with bandages. Sometimes coagulation occurs very rapidly (half an hour or so), but if no result is seen in a few hours, then, as a rule, compression alone will not be sufficient. Pressure produces such pain that except for short periods an anæsthetic is required. In most cases the treatment is aided by a little morphia to quieten the restlessness which is often present.

Pressure should be tried for a short time, at any rate, in all accessible aneurysms before proceeding to other measures. It is, however, at times dangerous, and may cause an aneurysm to burst when applied below it. It should *not* be used if the patient is very restless, if the aneurysm is very large and appears likely to burst soon, or if there is much venous obstruction or œdema.

II. **Ligation** of the vessels.

(*a*) *Proximal.*—(1) *Anel's* method, where a ligature is placed *immediately above* the aneurysm. This method is sound and efficient if used with antiseptic precautions. (2) *Hunter's*, ligation at a point some *distance from the aneurysm*, with at least one lateral branch between the aneurysm and the ligature. This method was introduced from the idea that the artery near an aneurysm was less healthy than at some distance, and that ligation near it was apt to fail. It is now understood that the artery is not less healthy near the aneurysm, but that the failures were due rather to sepsis.

(*b*) *Distal* ligation. (3) *Brasdor's* method, tying the artery *immediately below* the sac, so that the circulation through it is completely stopped. (4) *Wardrop's*, tying one or more of *the branches* of the exit artery.

In (2) and (4) the circulation through the sac is not completely stopped, but greatly diminished, and clot forms gradually.

(*c*) Complete isolation of the aneurysm, with ligation *above and below.* (5) Method of *Antyllus*, where the sac is laid open and the wound allowed to heal by granulation. (6) Method of *Matas*, where the walls of the sac with the overlying skin are enfolded so as to obliterate the sac ; or (7) with *extirpation* of the sac and closure of the wound.

Of all those the latter two are the methods of choice where they are possible.

III. A method of **arteriorrhaphy** has been devised by *Matas*, and tried with some success, of laying open an aneurysm ; and in the sacculated form (*a*) *closing the opening* into the diverticulum by suture ; while in the fusiform variety (*b*) a *new canal* is made by suturing the wall over a rubber tube temporarily introduced, after the manner of Witzel's gastrostomy.

IV. Introduction of **coagulating agents** into the sac.

Coiled wire (silver, gold, or steel) is sometimes introduced in lengths of 10-30 feet or so, and coagulation takes place around it, and consolidation follows.

A long fine *steel needle* may be introduced (*Macewen*), and made to impinge on the opposite wall. This sets up a point of irritation and inflammation, which leads to fibrous thickening of the wall and to deposit of fibrinous clot. The needle is made to touch or even penetrate the wall at several points so as to involve a large surface.

Those methods may be used when all other means of treatment are inapplicable.

Manipulation of the sac to loosen the clot and cause embolism of the arteries below the aneurysm, and introduction of coagulating fluids (iron or other salts), are methods which are now wisely given up.

Electrolysis, unless performed with accurate knowledge and careful measurement of the current, should not be used.

V. When all other methods fail, the only remaining resort is to **amputate** the limb.

Results of Ligation.

(1) If the circulation is sufficiently diminished, or stopped, in the aneurysm, *pulsation ceases in it*, and it shrinks and consolidates from contraction of the clot. This becomes organised, and finally remains as a shrunken fibrous mass.

(2) The branches of the artery dilate soon after ligation of the main trunk, and by their anastomotic connections carry on the circulation of the limb (*collateral circulation*). In order to favour this, the limb is slightly raised after the operation, and is well wrapped up in cotton wool to keep it warm. The limb is at first rather colder than normal, from the small blood flow through it, but if collateral circulation is sufficient, it regains its natural warmth in 6-48 hours.

(3) Should *pulsation return* in the sac, the operation is unsuccessful. This may be due to (*a*) inefficient tying of the vessel,—looseness, or slipping of the knot; (*b*) too rapid absorption of the ligature (*e.g.* plain catgut); (*c*) too great a flow of blood through the aneurysm (in Hunter's operation); (*d*) regurgitation of blood from below.

Treatment.—Pressure may be used as before; ligation may be repeated, with ligatures applied to more, or all, of the afferent and efferent branches; or, when all these means fail, amputation must be performed.

(4) *Sepsis* may occur, resulting in *secondary hæmorrhage*, *septic phlebitis* (*q.v.*), or *suppuration in the sac.* These are all of extreme danger.

Treatment.—Cut down on the sac, tie all branches possible, and pack the wound with antiseptic gauze. Amputate where necessary.

(5) *Gangrene* of the limb may ensue from insufficient collateral circulation, or from pressure or injury of veins preventing venous return.

Treatment.—Amputation, as soon as line of demarcation is evident.

Arterio-venous Aneurysm.

Wounds of an artery and vein are sometimes made simultaneously, especially in war, by modern high-velocity rifle bullets. When this occurs, blood is poured out into the space between the vessels, and healing may take place by union of the openings. When these join directly, an **aneurysmal varix** is the result; if they are joined by means of a sac (the site of the diffuse aneurysm), it is called a **varicose aneurysm.**

In both cases the veins become distended, varicose, and pulsatile, from entrance of arterial blood at high pressure into the weak-walled veins. A pulsating tumour, varying in shape and size, is then produced. Pain is often present, and a bruit is heard on auscultation.

Treatment.—In slight cases pressure with an elastic bandage is sufficient. In more severe cases, where there is great distension, and in all cases of varicose aneurysm, the connection from the artery should be divided and the opening closed with lateral ligation or suture. If this cannot be done, the artery should be tied above and below and divided.

Special Aneurysms.

Internal aneurysms are usually treated by the physician, but sometimes they require surgical measures.

Aneurysm of the **Aorta** is one of the most frequent varieties, and when, as is most often the case, the arch is involved, it may present as a rounded, pulsating tumour above the sternal notch.

The **symptoms** are those of pressure and displacement, and vascular disturbances. (See a work on Medicine.)

Treatment.—The only surgical measure advisable is acupuncture, by Macewen's method. The skin is prepared as for an operation, and the needle sterilised by boiling. If the swelling presents above the sternum the needle is introduced there, otherwise it may be entered between the ribs at the point where the sac wall is found to be nearest.

Abdominal aneurysms may occur in any part of the abdominal aorta, but more commonly at its bifurcation. The mesenteric, hepatic, or splenic arteries may be the seat of aneurysms.

Symptoms.—Local discomfort, feeling of pulsations; if the vertebral bodies are eroded there is persistent boring pain, usually in the loins or navel. There may be symptoms of pressure, causing obstruction of the bowels.

Diagnosis must be made, chiefly by the absence of *expansile* pulsation, from tumours, or fæcal masses, with pulsation transmitted from the normal aorta beneath.

Treatment.—Proximal compression by tourniquet (*Lister's*), or by the closed fist (*Macewen*), for some hours. (The patient is laid on a low bed, and the surgeon, standing at the left side of the patient, with his arm straightened and the fist closed, presses the aorta against the spinal column; this occasions little strain to the operator.) An anæsthetic may be employed with advantage.

Aneurysms at the **root of the neck**, arising from the great vessels, are rather more accessible. Sometimes, when situated close to the aortic arch, they are difficult to distinguish.

In aneurysm of the innominate a pulsating tumour is felt lying beneath the origin of the sterno-mastoid muscle; and the pulsation in both the radial and carotid arteries has aneurysmal signs—delay and diminution. In aneurysms of the carotids the tumour appears to the inner side of the sterno-mastoid, and the pulse in the (external) carotid is felt to be affected. In subclavian aneurysm the tumour lies to the outside of the sterno-mastoid, and the radial pulse is aneurysmal, while the carotid is unaffected.

Aneurysm of the **innominate** may be fusiform, or sacculated, affecting any part or the whole of the artery. It is often associated with dilatation of the aortic arch.

Symptoms.—A tumour is found behind the origin of the sterno-mastoid, displacing, as it grows, the muscle or the trachea. There is dulness on percussion at the inner end of the clavicle; bruit is usually heard, but may be absent; the pulse both in radial and carotid is affected; pressure may cause dyspnœa, stridor, hoarseness, dysphagia; there is engorgement of veins, with œdema; pain down the arm and up the neck; dilatation of the arteries, sweating, and pupil-contraction, on the same side of the head from pressure on the sympathetic.

Death occurs from asphyxia or rupture.

Treatment.—Constitutional, along with ligation of the common carotid, *and* the subclavian arteries. If this is impossible or insufficient, acupuncture may be tried.

Aneurysm of the **common carotid** commences as a small tumour to the inner side of the sterno mastoid.

Symptoms.—Dyspnœa and spasmodic cough (pressure on trachea); hoarseness and loss of voice (on recurrent laryngeal nerve); dysphagia (on œsophagus); contracted pupil, sweating of half of the head (on sympathetic); feeling of pulsation in the head, giddiness, tinnitus aurium, dimness of vision (from vascular disturbances).

Diagnosis, from enlarged glands and tumours over the artery, and pulsating goitres.

Treatment.—Wherever possible, proximal ligation should be tried. The chief danger of this treatment is from cerebral anæmia, leading to softening of the brain. The artery may be compressed against the transverse process of the 6th cervical vertebra; the vagus nerve, however, in close proximity, may be injured in doing this.

Aneurysm of the **external carotid** may involve the hypoglossal nerve, and give rise to paralysis of the tongue.

Treatment.—Ligation and extirpation.

Aneurysms of the **internal carotid. Intra-cranial** aneurysms are not usually diagnosed, except from symptoms following rupture (apoplexy).

Intra-orbital aneurysms (aneurysm of the ophthalmic artery, or rupture of the carotid into the cavernous sinus, usually of traumatic origin) are characterised by exophthalmos; pulsation in the orbit; thrill; and congestion of the conjunctiva; with, occasionally, paralysis of muscles; dilated pupil; opacity of the media; and the appearance of pulsation in the vessels of the fundus, when that is visible.

Diagnosis, from pulsating sarcoma, and thrombosis.

Treatment. — Constitutional treatment, with rest, and potassium iodide, is often sufficient to cure it. In resistant cases the internal carotid may be tied.

Subclavian aneurysm occurs usually in the third part of the artery, and more commonly on the right side of the body.

Symptoms.—A tumour in the supra-clavicular triangle, displacing the sterno-mastoid, or the pleura below; the radial pulse affected; venous engorgement and œdema of the arm and of the neck (from pressure on the jugular vein); pain or numbness, and weakness in the arm.

Treatment.—In the first part: constitutional, with acupuncture, or distal ligation of all accessible branches. In the second part: proximal ligation, if possible; if not, distal ligation. In the third part: double ligation and excision of the sac, with division of the clavicle, to allow free access to the artery. If these means fail amputation must be performed at the shoulder.

Axillary, brachial, radial, ulnar, and **digital** aneurysms should be treated by double ligation and excision. Forced flexion for aneurysm at the bend of the elbow may be tried for a short time.

Inguinal aneurysms, involving the external *iliac* or *common femoral* arteries, often combined, form tumours about Poupart's ligament, extending into the iliac fossa, or down the thigh.

Symptoms.—Lividity and œdema of the leg; pains, shooting down the inside of the thigh (pressure on the anterior crural nerve); and a pulsating tumour.

Diagnosis, from enlarged glands, or abscess over the artery.

Treatment.—Transperitoneal ligation of the external iliac, or if necessary, the common iliac artery. If this is contra-indicated, aortic pressure may be employed.

Gluteal, *i.e.* aneurysms of the *gluteal, sciatic,* or *pudic* arteries, lie deep in the buttock.

Symptoms.—Pain in the hip; limitation of movement; pulsating tumour.

Treatment.—Ligation of internal iliac artery, with or without subsequent ligation of the branches of the artery in the buttock, and excision of the sac.

Femoral, tibial, or **pedal** aneurysms are treated by excision.

Popliteal aneurysm is the most common variety after aortic.

Symptoms.—Pain at the back of the knee, often shooting down the leg, to the ankle or toes; stiffness and impaired movement; cramps, muscular weakness, or paralysis; if it bursts into the knee joint there is swelling in the joint, with pulsation.

Diagnosis, from bursal swellings, abscess, or sarcoma.

Treatment.—Excision, under double ligation. Forced flexion may be tried for small aneurysms.

Diseases of Veins.

Thrombosis, or clotting of blood in vessels, is common in veins.

Causes.—(1) Changes in the *blood,* with tendency to coagulation, from various circumstances, but especially destruction of leucocytes with liberation of *fibrin ferment.*

(2) Changes in the *vessel walls*: (*a*) presence of foreign bodies, including emboli, ruptures, denudation of endothelial lining; (*b*) *infection* resulting in inflammation arising from the surrounding tissues or from septic emboli.

(3) Stagnation of the *blood stream*, (*a*) from weak heart's action, and (*b*) obstruction, due to varicose dilatations, or pressure of swellings, or displacement of organs.

Pathology.—The white blood corpuscles tend to adhere to the walls or to foreign bodies in the veins, and to form a nodule from which a clot spreads, either with or against the stream. The clot at the point of its origin is more or less *white*, from the excess of leucocytes in its composition; but when this grows large enough to block the circulation the vessel fills up with *red clot* of mixed corpuscles. When a thrombus is formed in stages it is *laminated* alternately white and red.

Changes in the Thrombus.—(*a*) Softening (fatty degeneration) and eventual absorption; sometimes, however, causing embolism. (*b*) Organisation of the clot by invasion of the vasa vasorum, which replace it with granulation tissue. The result may be a permanent fibrous cord, or it may be tunnelled with new blood-vessels, and the vein subsequently reopened; or it may be infiltrated with lime salts (*calcification*), forming so-called "phleboliths"; or (*c*) infected, with suppuration or septic embolism as a result.

Effects of Thrombosis.—There is always swelling and œdema, subsiding as collateral circulation is established. Phlebitis is not unusual, but generally of slight degree. Emboli may be detached and carried away, especially if the limb is moved while the thrombus is still soft. Those emboli, however, if aseptic, often give rise to no trouble, but sometimes they cause infarctions in internal organs. Gangrene occurs in some cases from complete obstruction of the circulation.

Symptoms.—In thrombosis of deep veins there is œdema of the limb and stiffness on moving; sometimes distinct pain on pressure over them, and dilatation of the superficial veins. If the superficial veins are thrombosed, there is, in addition, a cord-like swelling, with well-marked tenderness along the line of the vessel. In the absence of much phlebitis there is no redness or heat, and the body temperature is but little raised above normal.

Treatment.—Complete rest in bed, with immobilisation of the limb, which should be well wrapped up in warm flannel or wool, and slightly elevated to prevent excessive œdema; and when the thrombus is considered to be organised, or absorbed (6-8 weeks), gentle massage may be of use in order to remove the swelling, and a flannel bandage should be worn for some weeks after.

Phlebitis, inflammation of veins, may be (*a*) simple, or (*b*) infective.

Causes.—(*a*) Injury to the vein wall (ligation, burns, rupture); thrombosis; simple inflammation, spreading from the surrounding tissues; gout, and other diseases. (*b*) (Infective.) Direct infection by spreading of pyogenic organisms (*e.g.* in compound fractures, osteo-myelitis, otitis, erysipelas, and puerperal infections); also from indirect infections—from embolism, or septicæmia, following specific fevers; or from oral sepsis; and other sources of infection.

Phlebitis is most commonly met with in the veins of the lower limb, especially the saphenous veins, and sometimes in the jugular veins associated with infective diseases of the brain and middle ear.

The *simple* variety is usually confined to narrow limits, and is moderate in severity, and shows little tendency to spread.

Infective phlebitis is more important, as, in accordance with later researches, the greater number of cases of phlebitis is included in this group.

Pathology.—Whatever the cause, the walls are inflamed and swollen, and thrombosis of the vessel ensues rapidly. In non-infective cases the results are slight, and resolution may take place. In acute infective cases suppuration is common, and septic embolism and pyæmia, or abscess-formation, may occur.

Symptoms, in simple phlebitis, are those of thrombosis, with, however, pain and some fever always present at some time. In the infective inflammation pain and tenderness are constant; and in superficial phlebitis the outline of the vein is marked as a red band and a raised cord. In suppurating cases fluctuation can be made out sometimes; the limb is œdematous and often livid; the temperature is raised (102° F. and upwards), and there are other signs of inflammatory fever.

Treatment.—As in thrombosis, rest, with opium to control the pain if necessary. Remove the source of infection, if it can be detected. In the acute form, when there are signs of septic thrombosis, the vein should be exposed, tied, and opened, and the septic clot removed. The wound may be packed with antiseptic gauze and allowed to granulate; or the vein may, in some instances, be excised with its clot, and the wound closed.

Phlegmasia Alba Dolens is a chronic form of phlebitis which occurs after parturition. It is found to be associated with puerperal infection of the womb as an attenuated streptococcic infection, and is transmitted by the iliac and femoral veins to the leg, where it sets up its characteristic signs. The œdema is more or less solid, being caused by coagulated serum, and the swelling remains for a long time after recovery.

The **treatment** is that of thrombosis.

Varix.

Varix is pathological and permanent dilatation of veins.

Varicose Veins are met with chiefly in the lower limb, along the spermatic cord (*varicocele*), and around the anus and lower part of the rectum (*hæmorrhoids*).

Cause.—Though many conditions have been assigned as a cause, it is probable that the tendency to varicosity is *congenital*. The more proximate causes, however, are (1) sudden *strain*, resulting in rupture of the valves; (2) severe *intermittent pressure* on the veins, from vigorous exertion, with sudden variations of blood pressure; (3) *continuous pressure*, from long standing; from obstruction by thrombus, by portal and cardiac congestions, by the pregnant uterus, by pelvic or other tumours, or enlarged glands, or by fæcal accumulations, by tight garters, or ill-fitting trusses.

Pathology.—Varicose veins show dilatation, with some hypertrophy of the walls, especially of the middle coat; and, in old-standing cases, there are often signs of periphlebitis. The valves are functionless, as the dilatation prevents their meeting, and they often become atrophied. The column of blood, being unsupported, presses on the vein walls below and aggravates the condition. To accommodate the increased bulk of blood, the vein increases in length, and does so by making numerous lateral bendings. Continued obstruction leads to œdema, and to congestion of the venous radicles in the skin; it sometimes gives rise to *varicose eczema*. If this persists long the skin may break down, and a *varicose ulcer* is formed. Certain parts of the vein wall are liable to atrophic thinning, and further dilatation occurs at these points, giving rise to "*varicose cysts*." If the skin thins over these points the vein is apt to *burst*, and severe hæmorrhage is the result.

Varicose veins are specially liable to thrombosis and phlebitis, the cystic dilatations being usually the points of origin, and pulmonary embolism may result therefrom.

Symptoms.—In some cases, even of extreme degree, nothing is complained of but a sense of fulness. There is usually, however, fatigue and aching after long standing. Cramps in the limb may occur, but they are due, as a rule, to thrombosis of deep veins. Dilatation and tortuosity of superficial veins are characteristic, and the swelling disappears on raising the limb. If the skin is thin they are bluish in colour, and the venules are often visible as a network of blue lines. Œdema of the ankle and leg is common, especially when thrombosis has occurred. In old-standing cases there may be eczema or ulcers.

Treatment consists of moderate exercise and massage, in the early stages, to improve the circulation, provided always that there is no thrombosis; careful attention to the bowels; and avoidance of strain, fatigue, and especially standing long. If there is œdema, or if the deep veins are varicose, elastic bandaging with graduated pressure from below upwards, avoiding constriction at the top, is of value, and preferable to the use of elastic stockings.

Operative measures are called for when there is persistent pain or disablement, obstinate eczema or ulceration; when the veins are liable to injury; and when elastic pressure is inefficient. Sometimes an operation is required to qualify a patient for one of the public services. The object of operating in these cases is to remove the unpleasant effects; but in many cases all evidences of varicose veins disappear after operation. The methods most in use are—

Ligation, with division of the veins between two ligatures, (*a*) in the thigh, near to the entrance of the saphena into the deep vein; (*b*) of the dilated portions, near to, or below the knee, through a transverse incision, either completely round the leg, dividing all the branches (*garter*); or only over the most prominent veins.

Excision of (*c*) the varicose part: or (*d*) of that and the whole of the upper part of the saphena vein.

Of these methods, the last (*d*) is the most efficient when feasible. The utmost care must be taken to ensure asepsis, and the presence of eczema, or an ulcer on the leg, is usually a bar to operations in the vicinity. In such cases it is wise to ligate or excise the upper part of the saphena vein. The result of this, though not always permanent, so improves the conditions, that the ulcer may heal, and, if necessary, a more radical operation can be afterwards performed. For a network of superficial varicose veins below the knee, the "garter" method is often sufficient. The dangers of embolism must be kept in mind, and rest enjoined till the thrombus at the point of ligation is solid, in about four weeks.

Hæmangioma

Hæmangiomata, or nævi (congenital tumours composed of blood-vessels), comprise capillary and venous nævi. Arterial varix and nævo-lipoma may be grouped with these.

(*a*) **Capillary Nævus**, or *plexiform angioma* ("birth-mark"), is a mass of dilated capillaries bound together by a small amount of connective tissue. It occurs as a small flat elevated spot, reddish or bluish, according as arterial or venous blood predominates. The colour disappears temporarily on pressure, but returns at once when that is relaxed. Nævi occur chiefly in the superficial layers of the skin, especially of the face and scalp ("port-wine stains"), but are met with also on mucous membranes.

Course.—They appear at birth, and continue to grow for a time. They become more prominent during any act of straining, such as crying or coughing. As the child gets older, however, retrogressive changes may take place, and the tumours may ultimately disappear. In other cases they increase in size with the growth of the child.

(*b*) **Venous**, or **Cavernous Nævi** (erectile tumours), are soft, compressible tumours, composed of spaces lined with endothelium embedded in fibrous tissue, and communicating with veins. They can be emptied by pressure, and they enlarge with straining. They are generally of a purple colour, especially when the skin is implicated in the growth. The commonest situations are the lips, cheeks, genital organs; and sometimes the liver. Thrombosis is apt to occur in the spaces, and this sometimes leads to spontaneous cure. They may increase in size, or wither from degenerative changes.

Treatment.—Nævi, as a rule, give rise to no trouble; but operation is often called for to cure disfigurement. In some cases, however, malignant disease is found to follow on an apparently simple angioma; and in some situations (the bladder, for instance) the tumour should be removed. When a nævus does not increase in size it may be left alone; but if it grows larger it should be excised, to prevent subsequent complications.

(1) **Excision.**—The tumour is excised, along with a thin border of normal skin and subcutaneous tissue; if the incision is not wide enough severe hæmorrhage may occur, and the tumour usually reappears. The incisions must be planned to leave a small and unpuckered scar.

(2) **Electrolysis.**—When excision would sacrifice too much of the healthy skin (near the eyelids or lips), the resulting deformity is not compensated by the absence of the tumour. Obliteration may then be obtained by coagulating the blood, by the passage of a weak continuous current of electricity through the tumour. Positive and negative electrode needles are plunged into the nævus, and a current of 5-10 milliampères passed. Oxygen is set free at the positive pole and oxidises the fluids in the vicinity, causing a hard clot to form; while the negative pole forms a frothy clot, with liberation of hydrogen. The electrodes soon become polarised, and the current must be increased accordingly, or reversed from time to time. A galvanometer should always be used, in order that the strength of the current which is actually passing may be known. The operation should last for 5-10 minutes; and it should be repeated at intervals of ten days or so, until hardening of the tumour remains constant.

Cirsoid aneurysm, or *aneurysm by anastomosis*, is a pulsating tumour composed of a localised dilatation of arteries, veins, and capillaries. It is situated usually on the scalp. It is congenital in origin, and usually increases in size. Bleeding and ulceration may occur.

Treatment.—Excision, with ligation of the vessels.

Nævo-lipoma is a combination of nævus and lipoma, having the compressibility of nævus and the elasticity of lipoma. It should be excised.

CHAPTER II.

AFFECTIONS OF THE LYMPHATICS.

Injuries of the **lymphatic vessels** hardly ever give rise to trouble, as anastomosis between the channels is so complete, that the functions of the injured vessels are easily taken up.

The **thoracic duct**, however, is liable to rupture, especially in dissecting out tumours in the subclavicular region. Such rupture is recognised by a discharge of milky fluid, more copious after meals, which distends, or flows from, a wound if there is one; or, if it is due to a subcutaneous injury, there may be signs of filling up of the pleural cavity with chyle.

Treatment consists in opening up the wound, and packing it with antiseptic gauze. The discharge usually stops by filling up of the opening with granulation tissue. If chyle has entered the pleural cavity, it must be drained off.

The *large lymphatic vessels* of the *groin* or *axilla* are liable to injury in wide dissections for glandular affections. The scarring may result in setting up persistent œdema, often of a solid consistence. *Treatment* consists in graduated elastic bandaging and massage.

Lymphangitis, or *inflammation of lymphatic vessels*, may be acute, subacute, or chronic.

Cause.—It results from absorption of irritating material, especially the products of infection; and may start from a wound, prick, or abrasion; or in some cases, through the unbroken skin. It may arise also from stings, or insect bites.

Pathology.—The vessel walls become congested and swollen, and shed their endothelial cells. The lymph is increased in amount, and often coagulated (thrombo-lymphangitis). The lymphatic glands nearest the point of irritation become involved in the inflammation, but act as barriers to the spread of the disease. In acute cases the glands may be unable to do so, and the lymphatic vessels beyond them become affected. Around the glands is usually a zone of inflammation, and the blood-vessels may absorb some of the poisons, and give rise to toxic symptoms. Suppuration may take place in the lymphatic vessels, forming a *lymphatic abscess.*

Symptoms.—The line of lymphatic vessels is painful and tender, and surrounded with an area of œdema. The nearest glands are swollen and painful, and, in suppurating cases, fluctuation may be made out. If the superficial vessels are affected, they stand out as red lines in the skin, and sometimes may be felt as hardish cords. Inflammation of deep lymphatics is diagnosed by œdema, along with enlargement and tenderness of the concomitant glands.

Constitutional signs of inflammatory fever are present, and vary with extent and virulence of the irritation.

Treatment.—The part must be kept at rest, and if a limb is affected, it should be put on a splint and elevated. The source of the irritation is sought for and treated by drainage and antiseptic dressings. Fomentations are of use to dilate the blood-vessels and increase the effusion, and so counteract the poison. This effect may sometimes be increased by gentle elastic constriction. If suppuration takes place, free incisions must be made where the pus is found to be. Suppurating glands are to be opened as soon as possible. Pain may be relieved by painting the part with belladonna, or by internal administration of opium.

Special forms of lymphangitis are met with amongst butchers, and those who are employed in **dissecting**, or making **post-mortem** examinations, and generally of a virulent type.

Chronic lymphangitis is usually caused by tuberculosis or syphilis, and the vessels may be affected by the changes characteristic of these diseases.

Lymphadenitis, inflammation of **lymphatic glands**, is nearly always secondary to that of the lymphatic vessels. Sometimes the glands are affected alone, and occasionally without any obvious source of irritation. Infections from soft chancre, or from sore throats, are frequent causes; the glands are also affected in some of the specific fevers, notably in plague.

Pathology.—The glands, acting as filters to the lymphatic vessels, are themselves affected by the toxic agents which they retain and help to destroy. In *subacute* cases there is hyperæmia and infiltration with fibrinous exudation, which causes enlargement of the gland and distension of its capsule. The lymphocytes are multiplied, and the endothelium of the blood sinuses is shed. Resolution takes place after hyperæmia has subsided, with absorption of the exudate and proliferated cells, and regeneration of the endothelium. The inflammation usually affects the surrounding tissues (*peri-adenitis*); and if it lasts long, the gland becomes fixed in its place by adhesions. In acute cases, if suppuration occurs, a glandular abscess (*bubo*) is formed; in other cases, the gland, on section, may show patches of necrosis and hæmorrhage; while in rarer cases the whole gland may be found to be necrosed.

Complications which may occur comprise cellulitis, thrombophlebitis, and general infection.

Symptoms.—In acute lymphadenitis there is throbbing pain, tenderness on pressure, and often redness in the region of the swelling, and the skin may soften and break down. The gland is often immovable owing to periadenitis and œdema. Feverish symptoms are also present.

Treatment.—The primary source of infection should be sought for and treated, and the part kept at rest. Hyperæmia may be induced by the methods previously mentioned. If suppuration occurs, the gland must be opened either by puncture, or, better, by free incision; taking care not to injure the blood-vessels in the neighbourhood. In very virulent infections the glands should be excised entirely. When this is done,, the functions of the extirpated glands are taken up by development of the lymphatic substance in the fatty connective tissue in the vicinity.

Chronic Lymphadenitis.—Though chronic, painless enlargement of glands, especially those of the neck following sore throats and caries of the teeth, may persist for a long time, and ultimately subside completely without giving evidence of tuberculosis; yet in most instances chronic lymphadenitis is due to *tuberculosis* or, less frequently, to *syphilis*.

Ætiology.—Infection, when *tubercular*, occurs from existing lesions in the body, or from the skin; more commonly from the naso-pharynx, and in the abdomen from the alimentary canal. In these latter modes the primary source may show no sign of being affected. When infection is *syphilitic*, the "primary sore" infects the nearest glands only (hard bubo); while in the secondary stages the glands throughout the body are liable to enlargement, notably those at the back of the neck. *Simple* adenitis is dependent on long-continued irritation, such as eczema, pediculosis, or caries of teeth, and the like.

Symptoms.—The glands become enlarged slowly and without pain. They are at first movable, but become fixed by inflammatory adhesions, and the skin may be involved. They generally soften, and the central part breaks down into a curdy pus, which occupies a cavity of degenerated gland substance. If the skin gives way an ulcer is left, which is slow in healing (*vide* tubercle and syphilis).

Diagnosis.—Tubercular glands may have to be distinguished from *lymphadenoma* (*q.v.*); from primary or secondary *malignant disease*, by the rapid growth, more extensive adhesions and pressure effects, and usually more constant pain; from *fatty tumours*, by the history of slow growth, and absence of constitutional symptoms.

Constitutional disturbances vary much in intensity, sometimes being practically absent. In other cases there is anæmia, which disappears to a great extent on removal of the diseased tissues; want of appetite, and loss of weight are common: the temperature is often slightly febrile in the evenings.

Treatment.—Any source of irritation must be sought for and treated. Tubercular patients must have special constitutional treatment. The glands, in the early stages, before adhesions have formed, can be easily removed through a small incision; hence, if they do not subside quickly after general treatment they should be excised without delay. When softening occurs they may be punctured, to remove some of the fluid, and injected with iodoform emulsion, or other stimulating agent. This process may be repeated at intervals of a fortnight, until signs of cicatrisation show themselves. If the skin breaks down the diseased gland should be scraped out with a sharp spoon, the walls cauterised with pure carbolic acid, and the cavity packed with iodoform gauze. The infected edges of the skin are snipped off, and, at a later stage, the opening may be closed by a small plastic operation, in order to prevent the formation of an unsightly puckered scar. Objections have been raised that scraping of such a lesion is apt to lead to general spread of tubercle in the body, but the danger is probably exaggerated.

In *syphilitic* lymphadenitis the patient should have a course of potassium iodide; and if the swelling still remains, excision of the gland should be performed.

Lymphangiectasis is dilatation of lymphatic vessels, comparable to varix in veins; it is of congenital origin, but excited by obstruction.

Lymphatic varix and **lymphatic nævus** are met with in the spermatic cord and the mouth respectively, and resemble these conditions in veins without the blue colour.

Lymphangioma, tumour composed of lymph spaces dilated into cysts, and situated in the skin and subcutaneous tissue. Treatment, if they cause trouble, is excision along with a zone of the surrounding tissues.

Elephantiasis is a condition in which the skin and subcutaneous tissue become greatly thickened and rugose. It is due to chronic obstruction of the lymph channels. The most common cause is the presence of Filaria (causing Elephantiasis Arabum); but cicatrices from burns, cellulitis, or malignant disease have been known to cause a similar condition. The chief seats of the disease are the lower limbs and the scrotum; and the enlargement may reach enormous dimensions.

Treatment is usually confined to elastic pressure and massage; though, where the growth is very large, amputation of the limb, or part, may be necessary.

Lymphadenoma (Hodgkin's disease) is an affection in which there is enlargement of the spleen and lymphatic glands, and certain changes in the composition of the blood. It tends to end fatally.

Ætiology.—The cause is quite uncertain.

Pathology.—The glands are simply enlarged, and generally soft, though they are sometimes hard and fibrous. There is usually hypertrophy of the spleen. Sometimes small adenoid tumours are found in the liver, Peyer's patches, tonsils, and other lymphoid tissues. In the blood there is a diminution of red cells; the leucocytes are not increased, except to a slight degree as regards lymphocytes.

Symptoms.—There is always anæmia and loss of strength, and febrile temperature and indigestion are common; there is painless enlargement of the glands, usually beginning in the posterior triangle of the neck, and often involving those of the axilla and groin. The swellings are at first discrete, but become aggregated into masses, and may attain considerable size. They show little tendency to caseation or suppuration, and their chief danger is from pressure on important structures.

Diagnosis from *tubercular glands* is made by noting the absence of caseation, and of tubercles by microscopical examination: from *lympho-sarcoma*, there is no clear distinction but its comparatively rapid growth or its microscopic appearance.

Treatment is confined to general dietetic and hygienic measures. Arsenic is the only drug that seems to have any beneficial effect on the progress of this disease. If the glands are discovered when they form small isolated masses they should be excised.

Lympho-sarcoma occurs in lymphatic glands or other lymphoid tissue in various parts of the body. It resembles other forms of glandular swellings, and is diagnosed by a process of exclusion only. Treatment is excision.

Sarcomata of glands are found, as secondary growths, from infection through the lymphatic channels. Sarcoma, however, does not result so constantly in infection of lymphatics as does carcinoma. It occurs sometimes as a primary tumour.

Carcinoma of lymphatics is very common as a secondary growth, and the glands especially are often infected early by epithelial cells carried from the primary tumour. The larger lymphatic channels apparently often escape, but infective cells may be retained in the smaller meshes of the vessels which compose the minute lymphatic nodules so generally scattered amidst the fatty connective tissue. Should these be left behind at an operation for eradicating a cancerous tumour, the lymphoid tissue and cancer cells develop together into further secondary cancerous nodules.

CHAPTER III.

INJURIES AND DISEASES OF NERVES.

INJURIES OF NERVES.

Injuries in General.—Except where the nerve is severed or permanently compressed, recovery is the rule; and the treatment is confined to keeping the limb at rest, to prevent tension on the nerve, and applying friction and massage to the limb, to prevent wasting of the muscles from want of use.

Wounds of Nerves.—If a nerve is completely **divided** the ends retract slightly, and there is entire loss of its function.

Pathology.—If the divided ends remain ununited the *proximal end* becomes bulbous, and the terminal parts of the fibres become degenerated for a short distance. Then new medullated fibres become proliferated by development of the nerve corpuscles, while the connective-tissue corpuscles also form an overgrowth. These become coiled up together, thus constituting a "*false neuroma.*"

The *distal segment* shows signs of much greater changes. The nerve degenerates, ultimately in all its length, by breaking up of the myelin of the medullary sheath, and softening and disappearance of the axis cylinders. Inflammatory changes, involving the connective-tissue cells of the endoneurium and nerve corpuscles, follow, by which the remains of the old nerves are removed, and new tissue is laid down in a fibrillar arrangement. These fibres do not assume the form of normal nerves (axis cylinder, medullary sheath, sheath of Schwann, and nuclei or nerve corpuscles) unless a junction is made with the proximal end, calling forth a functional activity. When this occurs the immature nerves gradually develop to adult form.[1]

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[1] Other theories of nerve-regeneration are widely held, but this seems to be the most satisfactory at present.

Sensation returns rapidly, generally in a few days, even after long severance. Muscular action is slower in returning, months or years sometimes elapsing; and, indeed, after long division of the nerves only partial return of function can be hoped for.

The **effects of division** are—

(1) Abolition of *sensation* in the parts supplied by the nerve; this, however, is often restored, at least in part, by anastomosis of the terminal twigs with those of adjacent nerves.

(2) *Paralysis* of all the muscles supplied by the nerve, which persists until the nerve is reunited and regenerated. Certain changes in the muscles themselves also take place.

(3) Disturbance of *vasomotor* functions, resulting in variation in the temperature of the part; usually a rise, followed by a persistent lowering.

(4) *Trophic* changes, such as glazed, cold, and bluish appearance of the skin; falling out of the hair; hardening and cracking of the nails; "rheumatic" thickening in the joints; and alterations in the function of glands.

(5) Sometimes *neuritis*, with shooting pain, referred to the area of distribution of the nerve.

(6) Rarely affections of the *central nervous system*, such as epilepsy.

The changes in the muscles mentioned above begin to appear some time after the nerve-supply is cut off, and constitute what are known as the **reactions of degeneration.** The muscles do not respond to the faradic (induced) current, but they contract with the galvanic (continuous) current; the current which causes this contraction is less than that required to act on a normal muscle; the contraction is slow and tetanic, instead of being momentary: the effect of altering the poles is the reverse of the normal change, *i.e.* A.C.C. > K.C.C., while in normal reaction, K.C.C. > A.C.C.: as degeneration proceeds response to electric stimuli becomes less, and finally is abolished.

As the affected muscles degenerate, those opposing them tend to shorten and produce *deformities*.

Treatment.—In *recent wounds* the nerve ends must be sought for and drawn together. They are then united by passing a couple of absorbable sutures through them near the divided ends, and also one or two through the sheaths. In *old-standing divisions* the nerve ends, which are often bulbous and can be felt, should be exposed, the bulbous ends cut away till natural-looking nerve fibres are seen, and the ends sutured. If the ends are much separated they may be stretched to some extent, and the limb may be flexed in order to approximate them. When they cannot be made to meet, a number of strands of catgut may be stitched between them to form a bridge for the regenerating fibres to grow in and form a connection; or a nerve from a freshly-killed animal may be used instead, and probably it acts only in that manner. In other conditions a nerve may be *grafted* by inserting the freshened end into a slit in another nerve, when regeneration, with return of function, may ensue. The paralysed muscles should in all cases be kept in an active state by galvanism, the joints from stiffening by free passive movements, and the skin from destruction by massage and protection from cold or injury.

Subcutaneous rupture of a nerve is occasionally met with from injuries. The peroneal nerve, near the head of the bone, has been injured in severe wrenches; the circumflex, in dislocations of the shoulder; and the spinal branches of the brachial plexus, in delivery of "cross-births." The *effects* and *treatment* are the same as for wounds of nerves.

Contusion of nerves gives rise to pain and "pins and needles" in the area of the nerve's distribution. If the symptoms last for a long time, they are in most cases kept up by pressure of effused blood, but usually even they disappear in time.

Compression of nerves occasions at first pain and tingling, and later, numbness and paralysis. The most common seat is the musculo-spiral nerve, and the cause, involvement in callus, or pressure of crutches, etc.

Treatment consists in exposing the nerve, carefully separating all adhesions, and closing the wound. In some cases the nerve is destroyed by the pressure, and a part must be excised, and the two ends sutured.

Foreign bodies in nerves, such as needles and fragments of glass, give rise to sharp pain or spasm of the muscles.

Treatment.—Removal of the offending body.

DISEASES OF NERVES.

Neuralgia is nerve pain, and is due usually to pressure or inflammation of a nerve, or to ischæmia.

Neuritis, inflammation of a nerve, includes *perineuritis* (inflammation of the nerve sheath), *interstitial neuritis* (of the connective tissue between the fibres), and *parenchymatous neuritis* (of the nerve fibres themselves with degeneration).

Ætiology.—The causes comprise—I. Local: (*a*) injuries and strains; (*b*) exposure to cold: (*c*) extension of inflammations in the neighbourhood; (*d*) infiltration of special diseases, leprosy, cancer, etc. II. General: (*e*) alcohol; gout and rheumatism; poisons of diphtheria, influenza, etc.: (*f*) arsenic, lead, and other metallic poisons.

Pathology.—In inflammation affecting the connective tissue there is hyperæmia and infiltration with leucocytes. If the nerve lies in a bony channel, pressure of this effusion causes compression of the nerve fibres, leading to loss of function; and if it is persistent, part of the nerve may be destroyed, with degeneration of the distal part. When a nerve is infiltrated with new formation the fibres are replaced by its cells.

Symptoms.—There is boring or stabbing pain, more or less continuous, but increased to paroxysms by movement or anything which causes congestion. The pain often radiates beyond the limit of the distribution of the nerve. Where the nerve lies superficially it may be felt as a swollen cord, and pressure on it usually produces severe pain. If degeneration is taking place there is progressive loss of function, and tingling or spasm, going on to numbness or paralysis. Trophic changes, such as herpes and glossy skin, are common. Occasionally the process spreads upwards—*ascending degeneration.*

Treatment.—The cause must be sought for, and the source of irritation removed; and all general conditions bearing on the disease treated—anæmia, malaria, etc. Relief from pain may be obtained by opium, but this should be used only as a temporary measure, and all possible efforts made to obviate inducing the drug habit. Chloral and phenacetine are also valuable for this purpose, and in severe paroxysms chloroform may be administered. Potassium iodide is used to aid absorption of inflammatory thickening, often with good results, especially in syphilitic neuritis. Locally, belladonna, hot fomentations, and hot air; counter-irritation with blisters or actual cautery often relieves the pains.

Operative measures are indicated if pain still persists, viz. (1) stretching the nerve, (*a*) by forcible flexion, or (*b*) through an incision; or (2) separating adhesions round it; (3) excision of the diseased part of the nerve, with subsequent suture of the ends; (4) destruction of the nerve (*a*) by injection of osmic acid (1 per cent solution), (*b*) by excision or avulsion, or (*c*) by removal of a ganglion (*e.g.* Gasserian).

Affections of Special Nerves.

Trigeminal Neuralgia, "tic douloureux," is a painful neuritis of the fifth nerve or its branches. It occurs in old people, and has been ascribed to ascending neuritis spreading from irritation of the teeth, from influenza, or from pressure of effusion in the bony channels of exit from the skull.

Symptoms.—The pain is either continuous or, more commonly, paroxysmal in incidence, and often induced by blasts of cold air. Twitching of the face and watering of the eyes sometimes accompany the paroxysms. Any or all of the branches may be affected, and the pain is referred to the terminations of the nerve. It generally persists in spite of remedies, and operative interference is called for. When this is inadvisable, the only alternative is drugging with opium.

The affected branches should be treated separately at first; the stem being divided, and the root torn out by a twisting movement. The **supra-orbital** branch may be reached by an incision over the eyebrow. When the eyeball is affected, the **ophthalmic division** may be found under the roof of the orbit, where it may be seized and torn out of the sphenoidal fissure. The **infra-orbital** nerve is treated in the same way, through an incision just below the level of the orbit; or the antrum may be opened, and the nerve root torn out from the foramen rotundum. The **inferior dental** nerve is reached at the mental foramen, or at its entrance into the lower jaw behind the last molar tooth. Here it can be caught on a hook and stretched or torn out. The **lingual nerve** may be excised for intense pain in the fore part of the tongue, through an incision between the root of the tongue and the angle of the jaw. The **auriculo-temporal** nerve is easily accessible for excision, lying behind the temporal artery.

The **second** and **third** branches can be exposed at the base of the skull immediately after their exit from the foramen rotundum and the foramen ovale, by temporary resection of part of the condyle of the jaw and the zygoma (*Krönlein's method*).

If those methods all fail to give relief, the **Gasserian ganglion** may be excised. The shock of the operation is great, and a modification has been made, to obviate this, by dividing the root of the ganglion, and interposing sterilised rubber-tissue between the cut ends, to prevent their reunion. The ganglion may be reached (*a*) through the temporal fossa, stripping up the dura mater (*Hartley-Krause*); (*b*) through a similar opening, but reaching the root of the ganglion intradurally. The bleeding in the second method is less, and so saves some time, but the shock is as great, and there is greater danger from extravasation of blood into the skull, with pressure symptoms resulting.

Facial spasm occurs sometimes in connection with trigeminal neuralgia, but may arise from irritation of the facial nerve alone. The nerve may be reached outside the stylo-mastoid foramen, and here it may be stretched. Paralysis usually follows, however, and division of the nerve is more reliable, without causing very much more disablement.

Facial palsy sometimes results from extension of inflammatory disease of the middle ear. To relieve this, the disease of the ear should be eradicated, and in some instances the aqueduct of Fallopius may be opened by means of a burr to relieve pressure. In persistent paralysis, the distal part of the nerve may be engrafted into spinal accessory or hypoglossal, with moderately good results.

Wry-neck (spasmodic torticollis) is due to irritation of some part of the spinal accessory nerve, with spasmodic contraction of the sterno-mastoid muscle. The head is bent forwards and towards the shoulder on the same side, while the face is turned rather to the opposite shoulder. The spasms often become worse on efforts of the patient to correct this. (For non-spasmodic wry-neck, *vide* section on the neck.)

The only efficient **treatment** is excision of part of the spinal accessory nerve as it enters the muscle.

Branches of the **brachial plexus** in infants are sometimes ruptured during birth, especially in "cross-birth." The nerves most commonly involved are the anterior branches of the fifth and sixth cervical nerves, and the paralysis corresponds to the distribution of those fibres. The nerves should be exposed, and the ends freshened and joined together.

The **musculo-spiral** nerve, which supplies the triceps, all the extensors of the forearm, and the supinators, along with the skin on the radial side of the back of the hand, the thumb, index and middle fingers, is sometimes torn or compressed in callus from fractures of the humerus; or compressed from a crutch (*crutch palsy*); or from hanging the arm over the edge of a table during operations; or over the back of a chair, in drunken sleep. The result is partial or complete paralysis of these muscles, and the effect produced is flexion of the wrist (*wrist-drop*), from failure of the opposing extensors, and loss of extension power of the first phalanx of the thumb.

The **median and ulnar nerves** are less commonly affected, but cuts at the wrist with broken glass are apt to implicate them.

The **median** nerve may be injured by fractures or wounds of the forearm. The muscles supplied are the pronators, the flexors of the forearm (except those supplied by the ulnar nerve), the abductor, opponens, and half of the short flexor of the thumb. Paralysis of these muscles entails twisting of the hand to the ulnar side; abduction and straightening of the thumb, with wasting of the thenar eminence; straightening of the first and second fingers, except for the action of the interossei. Sensation is lost on the palmar surface of the hand and fingers, except the little finger and half the ring finger.

The **ulnar** nerve is sometimes injured in dislocations of the shoulder, and injuries of the elbow, forearm, or wrist. The muscles affected are the interossei, the two inner lumbricales, flexor carpi ulnaris, and half the flexor profundus, the adductor and inner head of the short flexor of the thumb. The hand is twisted rather towards the radial side; movements of the little finger are lost; and the hypo-thenar eminence is wasted; the fingers cannot be flexed at the first or extended at the second phalanx, and a form of "claw-hand" deformity is produced. The thumb loses its power of adduction. Sensation is lost to the whole of the little finger and the ulnar half of the ring finger.

Sciatica, or neuralgia of the sciatic nerve, usually follows exposure to cold or injury, and occurs, as a rule, in "rheumatic" subjects. The pain is referred to the thigh, the leg, or sometimes to the ankles and feet. It has to be diagnosed by pain, intensified by pressure along the line of the nerve; and differentiated from hip-joint affections by absence of pain in movements of the joint; from pain of tumours or aneurysms of the pelvis pressing on the nerve, by eliminating the possibility of their presence; from spinal or sacro-iliac disease and injuries to the superficial parts, by pain on deep pressure at the places.

Treatment must at first be general, *i.e.* anti-rheumatic, and attention to free movement of the bowels daily, with counter-irritation and hot-air applications. If these fail, the nerve should be stretched, by straightening the leg on the thigh and flexing the thigh on the body, under an anæsthetic; or, failing improvement from this, the nerve should be exposed in the fold of the buttock and stretched, or, better, relieved of all adhesions round it. After this treatment the limb should be kept in a splint for ten days; then gentle movement is allowed.

Perforating ulcer of the foot is a condition of atrophic change in the skin of the sole following injuries to the nerves of the lower limb. It arises from slight sores which do not heal, but go on to progressive ulceration. It is generally painless, and on that account it is often allowed to go without proper treatment for a long time.

Treatment.—Antiseptic dressings are applied, but if healing does not rapidly take place, the ulcer should be excised completely, and treated as a fresh wound. If possible, where the patient is not too old or weak, the nerve condition should be attended to. Usually, however, that is not possible, as the lesion is often central.

CHAPTER IV.

AFFECTIONS OF MUSCLES, TENDONS, FASCIÆ, AND BURSÆ.

AFFECTIONS OF MUSCLES.

Contusions are very common, from falls and blows. There is generally some bleeding, and often partial rupture of the muscle fibres.

The **symptoms** are pain, increasing with movement; tenderness over the spot; swelling from effusion; and often ecchymosis. There is some loss of power from the pain, and later from partial atrophy. Suppuration is apt to ensue where there is much effusion.

The **treatment** is rest, with firm pressure by bandaging where possible, and *early* application of cold to prevent excessive bleeding. In the later stages, massage and graduated movements should be used, to restore the action of the muscles.

Wounds of muscles, if *transverse*, gape widely, and should be sutured. If longitudinal they need not be sewed, as the edges fall together, but as a rule the sheath should be closed by interrupted sutures. The chief danger is from septic particles lodging in the loose and soft tissues, and giving rise to suppuration. Healing takes place by fibrous tissue, varying in amount with the extent of the intervening space to be filled.

Rupture of muscle may occur from sudden spasmodic action, especially in involuntary reflex movements, but also during violent exercise, and in dislocations. It is most commonly seen in the adductors of the thigh, the biceps of the arm, the gastrocnemius, the rectus abdominis, and the sterno-mastoid of infants at birth.

The **symptoms** are sudden pain, like a blow, followed by loss of function; sometimes a tearing feeling in partial ruptures (*strain*) from one fibre dragging on another. Immediately after, a gap is felt in the muscle, and above and below this a firm round tumour formed by the retracted ends, which increase in size if attempts are made to use the muscle. The gap is rapidly obliterated, however, by filling with blood clot.

Treatment consists in approximating the ends by suitable position and firm bandaging, and controlling the hæmorrhage by elevation, where it is possible. This is often sufficient for partial ruptures; but in complete rupture, with wide separation, it is better to suture the ends together.

Hernia of muscle, *i.e.* rupture of a muscle sheath with protrusion through it of the belly of the muscle, is rare, but is met with amongst athletes—the muscle usually affected being the rectus femoris. The **treatment** is suture of the sheath as in longitudinal wounds.

Atrophy of muscle ensues from *want of nerve function*, due to either central or peripheral causes. The fibres become smaller in size, while the intermuscular tissue is relatively increased; the whole muscle becomes thin and flabby. As atrophy progresses, the muscle cells lose their striation, and ultimately disappear, their place being taken by fibrous tissue. In the less advanced stages the muscles are soft and often tender; the reactions of degeneration (p. 136) appear; and finally there is no response to electrical stimulation.

There is another form of muscular wasting dependent on *disuse*, especially from disease of a joint. The wasting comes on rapidly, in 1-3 weeks, and remains stationary for a long time. If the disuse is temporary the muscles recover in a short time; but if due to chronic inflammation about a joint, there is often some fatty degeneration and permanent wasting.

Hypertrophy of voluntary muscles is seen in athletes and labourers. Hypertrophy of involuntary muscles occurs in the intestines, the ureters, etc., and is due to the efforts to overcome obstructions (*v.* diseases of regions).

Myositis, inflammation of muscle, depends on traumatisms —bruises, ruptures, or strains—rheumatism, syphilis, or more rarely tubercle by extension from other structures. In traumatic cases suppuration may follow, leading to destruction of many of the fibres, and subsequent replacement by cicatricial connective tissue. This gives rise to *contracture* at a later stage. Rheumatic myositis may give rise to nodules of inflammatory tissue between the fibres, very painful to the touch and difficult to locate.

Treatment.—Rest, with the use of a splint or sling where available, is generally sufficient in slighter cases. Rheumatic cases should be treated with salacin and quinine in fairly large doses till pain is relieved, and with other general measures; syphilitic, with potassium iodide; and tubercular, by excision of the parts along with the other tissues. In suppurative myositis, the muscle must be incised in the line of its fibres, and in dangerous situations by Hilton's method, followed by free drainage.

Contracture of muscle is permanent shortening, usually with some hardening and rigidity, causing deformity of the limb. It is due to (*a*) results of myositis; (*b*) pressure of splints or bandages during the swelling stage of an injured limb (*Volkmann's ischæmic contracture*); or (*c*) to paralysis and degeneration. In the first two cases there is hyaline degeneration of some of the muscle fibres and replacement by inflammatory connective-tissue cells, the other fibres remaining normal. The connective tissue contracts and causes shortening and loss of power.

Symptoms.—The electric reactions are normal as regards their character, but diminished in extent; there is thus no real reaction of degeneration.

Treatment consists in exercising the muscles to get the full use of the remaining fibres; and lengthening the tendons, *i.e.* splitting them by Z-shaped incisions and suturing the ends together. When this cannot be done, the tendon may be cut across (*tenotomy*), and reunion takes place by fibrous-tissue growth, or a piece of tendon of another animal may be sutured in the gap (*transplantation*). In *paralytic contractures* all the reactions of degeneration are seen; and treatment depends on the cause of the condition. When it is due to nerve injury, electric stimulation and massage may be tried, to preserve the functions in prospect of late recovery. When a muscle is completely atrophied, the deformity may be minimised or improved by *transferring* the tendon (displacement), either whole or in part, of a sound muscle into that of the inactive one. To do this the functionating tendon is cut across near its insertion, a path bored for it through the intervening tissues by a blunt instrument, and the end sutured to the insertion of the non-efficient muscle. This is useful in some cases of club-foot.

Muscular spasm is due to nervous stimulation, either (1) central, as in injuries to the spine, or peripheral; (2) irritation of foreign bodies or inflammatory conditions causing reflex spasm; (3) sudden application of cold, as cramp in bathing; (4) overstrain of a particular set of muscles (*writer's cramp*).

Treatment consists in removing the cause of irritation, and in the case of over-use in maintaining rest, with a suitable splint to prevent permanent contracture, and abstention from use for a time. Constitutional treatment for the general health is important in these cases.

Myositis ossificans is a rare disease in which masses of bone are formed in muscular tissue, in various parts of the body.

Ossification of muscles and tendons sometimes occurs from excessive use or frequent slight strains.

Pathology.—It is probably due to slight hæmorrhages beneath the periosteum at the insertion of the muscle. The effused blood has a strong influence on the action of the osteophytes in the immediate vicinity, and results in laying down of bony tissue, similar to callus formation. It is found chiefly at the insertion of the adductors of the thigh (*rider's bone*), or in other parts.

Treatment.—If it gives pain or interferes with function, the new-formed bone should be excised.

AFFECTIONS OF TENDONS.

Wounds of tendons.—Where a tendon is divided the ends retract into the sheath. In an open wound they should be sought for and joined together by suture: if more than one is divided, care must be taken to join the right ends. In cases of old standing, the ends should be traced down from the muscle, and the extremities freshened and sutured together. The limb must be so placed that the muscle is relaxed to allow the tendons to meet. If the distance is too great, the upper end may be lengthened by splitting it from above downwards to within a quarter of an inch from its free end, turning this tag down, and suturing it to the other free end. Another method of lengthening is to make a series of transverse cuts along its edges three-quarter way through, alternately at opposite sides, and stretching it to form a number of zigzags.

Or a graft may be fixed between the two ends. Passive movements should be begun in ten days, to prevent adhesions to the tendon sheath.

Rupture of a tendon occurs, generally in elderly people, as a consequence of sudden and unaccustomed strain. The tendo Achillis is often so torn in hopping, dancing, etc.

The **symptoms** are sudden pain like a blow from a stick, loss of power, and a feeling of a gap in the line of the tendon.

Treatment.—With the joint fixed in a splint and the muscles relaxed, the tendon usually readily unites by fibrous tissue. Where this does not take place, the ends should be exposed and sutured.

Dislocation of a tendon from its sheath is uncommon, except in gross injuries. It does occur, however, in the wrist and the ankle.

The **symptoms** are pain and swelling at the proper seat of the tendon, loss of function of the muscle, and appearance of the tendon standing out as a cord in the new place.

Treatment.—It should be replaced by manipulation, and kept fixed by firm pressure, with the limb in a splint or plaster-of-Paris. If this fails, an attempt should be made to form a new sheath by dissecting up a layer of fibrous tissue or periosteum.

Teno-synovitis, acute inflammation of the tendon sheath, commonly results from over-use, especially in rowing, and more often in "rheumatic subjects." There is pain along the tendon and a feeling, or sometimes a sound, of creaking. This is lost if the effusion increases, and an elongated swelling is then seen. The skin is sometimes reddened and indurated.

Treatment.—Rest in a splint, or simply in a sling, is usually sufficient. In more severe subacute cases, counter-irritation by blistering, iodine, etc., is useful, followed by passive movements as soon as the inflammation subsides.

Suppurative teno-synovitis (*thecal abscess*) occurs from septic infection, most commonly by extension from a *paronychia* or *whitlow.* The suppuration spreads rapidly in the sheath, and the blood-vessels of the tendon are soon blocked. This readily leads to sloughing of the tendon if the infectious matter is not quickly let out.

The **treatment**, therefore, is early opening of the tendon sheath and free drainage. If the annular ligament is in the way, it should be avoided if possible. Circulation in the part must be encouraged as much as possible, by warmth or partial constriction (passive hyperæmia). The dressings should be changed frequently, or a continuous bath of weak antiseptic employed.

Chronic teno-synovitis is usually tubercular, and the lining membrane is affected with tubercles as in a joint (*q.v.*). A frequent result of this is desquamation of the lining cells, which become rolled together to form "*rice-like*" or "*melon-seed*" *bodies*. When these are examined, they are usually seen to be of homogeneous fibrous appearance, but tubercle bacilli may be found in them. Thickening or caseation may occur in the diseased membrane as in other tubercular lesions.

Symptoms.—A doughy swelling is seen in the position of a synovial sheath (*compound ganglion*), which may be a single tumour or spread into the adjoining sheaths. Fluctuation may be obtained by pressing alternately at the ends, and the "rice bodies" may sometimes be felt to slip from one part to another. The movements of the joint are free, unless the process spreads to it. The most common sites are the wrist and ankle.

Treatment.—If possible, the sheath should be dissected out entire, and the annular ligament saved. The joint is kept at rest, and healing should take place by first intention. If the sheath cannot be entirely removed, all visible tubercle should be scraped away, and iodoform injected, and the wound closed. Healing takes place as in other tubercular tissues.

Ganglion is a cystic distension of a tendon sheath by accumulated synovial fluid, following simple chronic teno-synovitis. The cyst usually feels hard from tension of the fluid, the fluid itself being clear and gelatinous in consistence. Sometimes fluctuation can be made out, and "rice bodies" may be present.

Treatment.—A small ganglion may be emptied by a sharp blow, and the fluid dispersed into the soft tissues. Larger ones should be excised completely, or, if that cannot be done, incised with a tenotomy knife, and emptied. If they re-accumulate, iodoform or other irritant may be injected to cause an obliterating inflammation.

DISEASES OF FASCIÆ.

Contracture of fascia may develop when the other structures in apposition are contracted, as in club-foot; and the deformity is maintained by it after the other causes are removed.

It also occurs apparently spontaneously in the palm, **Dupuytren's contracture**, an affection of middle age, and confined almost exclusively to males. It is probably inflammatory in origin, and is often subsequent to irritation on the palm from the handles of tools, etc.

Pathology.—There is new formation of fibrous tissue in the fibres of the palmar fascia, usually appearing first in several spots. This is spread along the fibres which run to the fingers, and merges with the tendons at both sides of their insertions.

Signs.—It usually begins at the metacarpo-phalangeal joint of the fourth or fifth finger, and is insidious and painless in its onset. Flexion is not impaired, but extension is gradually restricted, until in some cases the nail cuts into the palm. Attempts to extend the fingers forcibly are extremely painful. There is also some puckering of the palm, and the condition is steadily progressive.

Treatment.—In the early stages, persistent movements of over-extension, with intermittent use of fixation apparatus, prevent advance of the condition ; this treatment may be aided by massage and baths. When small single bands can be felt in slight cases, they may be divided subcutaneously between the two articular folds, and manipulative treatment persisted in. In advanced cases the palmar fascia should be excised, by raising flaps of skin, or if necessary sacrificing parts of it, and subsequently grafting the wound.

AFFECTIONS OF BURSÆ.

Adventitious bursæ may be formed wherever there is friction between two movable parts such as tendons ; or over a bony prominence, as in bunions.

Acute bursitis is generally excited by injury or undue pressure. The part becomes hot, swollen, and somewhat œdematous, and there is pain on pressure and movement. Suppuration is apt to occur if the bursa is situated immediately beneath the skin.

Treatment is at first confined to rest and cooling applications, to lessen hyperæmia. The fluid may be removed by aspiration or a small incision. If suppuration ensues the bursa must be opened freely and drained.

Chronic bursitis is often consequent on acute bursitis; or it may arise from frequent interrupted pressure. It may be due to tubercle or syphilis, and, like teno-synovitis, is more common in "rheumatic subjects." "Melon-seed bodies" may be met with, but not often.

The **signs** are thickening of the bursa, and distension to form a round fluctuating lump. Pain is often absent, but there is discomfort and interference with the use of the limb.

Treatment.—In simple distension, strapping with counter-irritation or aspiration is often enough to cure the condition. Sometimes a silk thread is passed through the bursa, and allowed to act as a capillary drain. If it persists, the best treatment is complete excision. This is specially the case in tubercular bursitis.

Gouty bursitis is infiltration of the sac and walls with uric salts, forming very painful swellings. The sac may be opened and emptied of its grit. Anti-gouty treatment is, of course, added.

Special forms of *bursitis* are met with, *e.g.* in the prepatellar bursa causing *Housemaid's knee*, from constant kneeling with the body bent forwards as in scrubbing the floor. Inflammation of other bursae gives rise to conditions known as *Nun's knee*, from kneeling in the upright position (over the tubercle of the tibia); *Weaver's bottom* (over the tuberosity of the ischium); *Miner's* or *Student's elbow* (over the olecranon). Enlargements are also common over the trochanters, under the semimembranosus tendon and psoas muscle.

CHAPTER V.

INJURIES AND DISEASES OF BONES.

INJURIES OF BONES.

Fractures are the result of sudden violence which leads to loss of continuity.

Ætiology.—The *predisposing causes* are any conditions which render the bone unusually weak, *e.g.* extreme youth, when they are small and soft, or extreme age, when they are atrophied and brittle: long bones also are more liable to fracture than short ones, as they are more or less curved. Certain pathological conditions may predispose to fracture, amongst which are rickets, scurvy, osteo-malacia, osteo-porosis; malignant tumours and aneurysms; diseases of nerve centres, especially general paralysis and locomotor ataxy; syphilis, cysts, tubercle, osteomyelitis, and necrosis. These may cause such extreme weakening of the bones that fractures may take place without any noticeable violence, the so-called "*spontaneous fractures.*"

The *exciting cause* is *violence*, usually a bending strain, but sometimes twisting, tearing, or shearing. If the violence is *direct*, the bone is broken at the point of injury, often with much crushing of the soft parts; if *indirect*, when applied at a distance, as in fractures of the clavicle from falls on the hand, the bone breaks at the weakest point near to the greatest curvature, and the resulting fracture is often oblique or spiral. Some fractures are the result of *muscular action* suddenly and violently applied, as those of the patella.

Classification.—Fractures are either *simple*, when they are subcutaneous and uncomplicated by injuries to other parts, and especially without communication with the external surfaces: *compound*, when they communicate with the surface by means of a wound involving the skin or mucous membrane;

complicated, when associated with other injuries, *e.g.* dislocations, involvement of joints, main arteries, or internal organs; *multiple*, when there are several fractures in the same bone, or in different bones; *incomplete* or *green-stick*, in children, when the bone is bent and partially broken. *Complete*, *transverse*, *oblique*, *longitudinal*, *spiral*, T-, Y-, or V-shaped, *stellate*, need no explanation.

A fracture is said to be *comminuted* when the bone is broken into several pieces; *fissured*, when it is split, without displacement of the fragments; *depressed*, when one fragment is pressed in below the other, occurring commonly in fractures of the vault of the skull; *punctured*, when there is a perforation in the middle of a small depression; *impacted*, when one piece is driven into the other, usually into cancellous bone; *sub-periosteal*, when there is little displacement, and the periosteum is not torn; *intra-uterine* and *congenital*, when applied to fractures occurring before or during birth.

Displacements, when they occur, are *angular*, *i.e.* the line of the bone is bent; *rotatory*, *i.e.* twisted on its axis; *longitudinal*, *i.e.* shortened or lengthened; or *lateral*, *i.e.* depressed or overriding. The displacement depends on (1) the violence and direction of the injury; (2) muscular spasm; (3) the weight of the lower fragment; (4) injudicious movements of the limb by the patient or others; (5) the obliquity of the fractured surfaces.

When fracture is suspected, the parts must be **examined** with great care, lest a simple fracture may be made compound. The history of the injury, if obtained with accuracy, often gives valuable guidance to the subsequent measures. If the clothes cannot easily be slipped off, they must be removed by ripping up the seams; and the sound side should be stripped before the injured one. The corresponding limbs on opposite sides should always be compared, due allowance being made for occasional natural differences in size and length. The age of the patient and the condition of the health must be noted.

The **subjective symptoms** are (1) the *feeling* of a *snap* (this occurs also in ruptures of muscles and tendons); (2) *pain* at the point of fracture, which may be elicited by pressing or bending the bone at a distance from the point of injury: tenderness is of little value as a diagnostic sign of fracture, as it occurs from so many other causes, notably bruises; (3) loss or *impairment* of *function*, due to mechanical causes, or to pain or paralysis.

The **objective signs** are (4) *deformity*, viz. *swelling* from effusion of blood and serum, and, if a joint is involved, of increased synovial fluid; displacements as noted above; *alterations in shape* and *length*, determined by inspection and measurements; (5) preternatural *mobility*, and movement at a *new point*; (6) *crepitus*, which may be absent if soft tissues are interposed between the fragments, if the ends are impacted, or if the fracture is incomplete; (7) the appearance of the bone when examined with *X-rays* and screen.

Besides some or all of these, there is always a certain amount of shock proportionate to the violence of the injury. There is also some *fever*, commencing in a few hours, and resulting from the effusion of blood, and the liberation of toxins as it disintegrates. The fever is slight, and disappears in a day or two. Along with this the urine may show transient changes from normal; *albumen* in small quantities, *fat* globules, excessive amount of *bile* pigments may appear; and some *jaundice* may be noticed. In rare cases a considerable amount of fat may be liberated from the crushed medulla, and, being taken up by a vein, may be carried to the lungs, and there set up *fat embolism*. If suppuration takes place in a simple fracture the symptoms are those of septicæmia, as met with in compound fractures.

Diagnosis is to be made from bruises, from sprains, and dislocations, etc. This is often difficult if there is no displacement of the fragments and crepitus cannot be made out, or if there is much swelling from effusion. When much callus has formed at the seat of a fracture, there may be considerable difficulty in distinguishing it from sarcoma of bone. In cases of difficulty an anæsthetic should be given, and the limb examined thoroughly, care being taken not to cause undue injury to the soft parts, or to loosen favourable impactions. The fracture may be examined and manipulated under the X-ray screen.

Fractures are **repaired** by formation of **callus** which binds the fragments together. At the time of the injury blood is effused round about the broken ends, beneath the periosteum, which is thus raised off the bone for some distance, and into the adjacent soft tissues; and reparative inflammation begins almost at once. The fluid part of the blood becomes absorbed in a few days, while the cellular elements are removed by phagocytes and replaced with connective-tissue cells derived chiefly from the periosteum, but to some degree from the bone. The broken ends are now surrounded by a soft spindle-shaped mass of cells, permeated by a network of new-formed blood-vessels which are continuous with those of the Haversian system—the *external callus.* A similar mass fills up the medullary region—the *internal callus* ; and also lies between the ends of the bone —the *intermediate callus.* If union is long delayed from any cause, islands of cartilaginous structure appear in these masses. Otherwise ossification commences in them directly ; lime salts begin to deposit within twelve days or so, at first at the angle between the bone and periosteum, but spreading rapidly throughout the whole mass. This process is followed by true ossification. Thus a ferrule of bone is formed outside the fragments, a "liner" inside the medulla, and a ring cementing the ends together. The first and second of these gradually undergo absorption, and may ultimately disappear, while the intermediate part remains, and becomes consolidated.

If the fragments are overlapped they are joined together by an *interposed callus* ; and the solid walls of bone tend to be absorbed, thus making the medullary cavity continuous throughout the bone.

Repair varies in *rate* according to (1) the size of the bone, (2) the vitality of the part, especially as regards its blood-supply, and stimulation of the periosteum, and (3) the approximation of the ends and absence of movements.

Treatment.—The first duty of the surgeon is to allay the shock of the accident, and, in compound fractures, to stop the bleeding and apply a first dressing. The fractured limb must be fixed in a temporary splint to permit transport without further injury. For this purpose splints may be improvised of sticks, umbrellas, folded newspapers and magazines, etc., and the legs, if injured, should be tied together, one acting as a splint to the other. All fractures should be "set" or *reduced* as soon as possible, otherwise the difficulties are increased by muscular contractions, swelling, and inflammation, with formation of adhesions. When all apparatus required is ready, reduction is effected by traction on one end of the limb (*extension*), while an assistant holds the other (*counter-extension*). If the fragments do not then slip into position they are manipulated by the surgeon, while a second assistant relieves him of the traction, until the limb is restored as nearly as possible the same as the sound one. To facilitate easy reduction the muscles may be relaxed (1) by flexing the limb, (2) by using a general anæsthetic, which also allows of much freer manipulations owing to the absence of pain, (3) by tenotomy of any very resistant muscle. Impaction of fragments should be released and the parts manipulated into position, otherwise the union is apt to be faulty. An exception to this rule is intracapsular fracture of the neck of the femur. The fragments are *retained* in good position by many means—(*a*) sandbags, laid alongside the limb when the patient is in bed; (*b*) splints of various kinds, plain *wooden boards*, *Gooch's "kettle-holder" splinting*, which is easily cut to special shapes, *shaped wooden ones*, like *Cline's*, or *hoop-iron*, *wire*, *tin*, *aluminium*, all easily bent to shape; *plastic* splints of *poroplastic*, *gutta-percha*, *plaster-of-Paris*, *leather*, etc.; (*c*) *immovable* casings of *plaster-of-Paris*, *silicate of soda*, *starch*, *gum*, or *paraffin*.

Whatever splint is used, it must be well padded over the surface and the edges; it must not be allowed to press on any bony points, and should be cut away wherever it is likely to do so; it should not be applied too tightly, and the patient should be seen within twenty-four hours, to make sure that swelling has not interfered with the circulation—tested by pressing on the nails of the fingers or toes, and noting if the colour returns at once on releasing pressure; the joint above and below the fracture should be fixed at first, till callus is partly formed. The splints should be removed and *reapplied* if there is pain or numbness, any interference with the circulation by swelling, or shrinking, with loosening of the splints. Swelling may be prevented to great extent by firm bandaging of the limb from below upwards. Where possible, the X-rays and screen should be used to see that the fragments are in good position.

Failing satisfactory results by these methods, (*d*) extension apparatus by *weight and pulley*, or by *elastic cords*, etc., may be used; and (*e*) the fragments may be fixed *directly* by *screws*, *pins*, *wires*, or *absorbable sutures*. Operative treatment must only be carried out with full realisation of the necessity for strict asepsis, lest the result be worse than that of no treatment.

The *function* of the limb must be restored by early movement and massage, the fragments being meanwhile securely fixed between sandbags, or on a gutter splint. This may be aided by *ambulatory treatment*, *i.e.* letting the patient move about and use some muscles of the limb while the fracture is still kept fixed in some apparatus, like Thomas's splints or plaster-of-Paris. By this means the patient gets the use of the limb much sooner than otherwise; hence the economic value of the method.

The *general health* must be maintained; pain should be relieved by suitable means, and attention paid particularly to the regular action of the bowels, and to suitable feeding. In old people especially there is danger of hypostatic congestion of the lungs, and formation of bedsores; these are obviated by letting them sit up or lie on the side, and by strict attention to dryness and protection from pressure.

The bone is recognised to be **united** when there is no longer movement of the fragments on firm manipulation. In favourable circumstances the *phalanges* are united in 3 weeks; the *carpals*, *metacarpals*, *tarsals*, *metatarsals*, and *ribs* in 3-4 weeks; the *clavicle*, *ulna*, *radius*, and *fibula* in 5 weeks; the *humerus* and *tibia* in 6-7 weeks; *both* leg bones in 8 weeks; and the *femur* in 10-12 weeks.

Defective repair, which includes **delayed union**, **fibrous union**, **non-union**, and **false joint** or *pseud-arthrosis*, arises from such causes as (*a*) defective blood-supply from haemorrhage, fevers, wasting diseases, or insufficient stimulation of the part; (*b*) intervention of soft tissues (the most important cause), great displacement, overriding, imperfect contact of the surfaces; (*c*) excessive movements, with continuous irritative inflammation; (*d*) necrosis, or sepsis.

Treatment consists in (*a*) increasing the blood-supply by massage, local congestion, movement or rubbing of the fragments together, or even injecting some of the patient's blood into the seat of fracture (*Bier*); in stimulation of bone-formation by inserting ivory or bone pegs, or needles; (*b*) in removal of interposed tissues and freshening the surfaces with or without suture of the bone by wire, or absorbable material, or by staples (*Gussenbauer*), aluminium plates (*Watson Cheyne*), bone ferrules (*Senn*), or clamps (*Parkhill*); or (*c*) in grafting pieces of living bone, where there is great interval between the fragments. In *bone-grafting* it is probable that the introduced bone acts only as a scaffolding through which new bone formation takes place. Hence, in place of living bone, (*d*) decalcified bone, or even calcined bone, has been used with good results.

Separation of epiphysis sometimes takes the place of fracture at the ends of bones. It may occur up to the age of twenty-one, when the epiphysial line usually ossifies, but great violence is necessary to produce it.

Signs.—There are deformity and well-marked mobility, and often crepitus, but of a soft character. The fragments having a smooth surface are difficult to keep in their place, and union takes place rapidly; hence, if the injury is not properly reduced, considerable deformity may result. There is often much displacement of periosteum with effusion of blood, and suppuration is not uncommon as a sequel. The interference with blood-supply of the epiphysis sometimes tends to cessation of growth, resulting in stunting of the limb.

The **treatment** is that of fracture.

Complications of Fracture.

I. **Stiffness of joints** due to (1) arthritis, (2) teno-synovitis, (3) mal-position of fragments, (4) exuberant callus, (5) adhesions of muscles or tendons to the callus. This may be prevented to a great extent by early movements and massage, by careful reduction of the fracture, or by excision of the offending pieces of bone. It may be relieved by massage, movements, hot-air baths and douching, and by movements, at first under an anæsthetic, but later by the patient himself, sometimes aided by certain exercising apparatus.

II. **Atrophy of the limb** from (1) long inactivity; (2) from trophic changes, generally of nervous origin; (3) from compression (Volkmann's ischæmic contracture).

III. **Injury to Blood-vessels.**—(*a*) To the arteries, causing (1) extravasation, (2) hæmatoma, or a false aneurysm, (3) gangrene; (*b*) to the veins, causing (1) thrombosis, (2) embolism of the heart or lungs; (*c*) to both, from constriction by splints, causing (1) gangrene, or (2) ischæmic contracture.

IV. **Injury to Nerves.**—(1) Wounds or ruptures by sharp fragments; (2) involvement in callus; (3) crutch palsy (pressure on the musculo-spiral nerve especially, causing wrist-drop).

V. **Fracture into joints** is common in the region of the shoulder and the hip, and constant in the case of the patella and olecranon. There is great effusion of blood and synovial fluid, and generally stiffness of the joint ensues. To obviate this, the joint must be moved early and freely, even at the expense of obtaining only fibrous union, which is often sufficient for functional purposes. In intracapsular fractures of the femur, however, where there is impaction, it is better, on account of the poor blood-supply, to let the joint ankylose rather than disturb the new relations.

VI. **Fracture with Dislocation.**—If the fracture is not close to the joint, splints may be applied, and the dislocation reduced. If near the joint, an attempt may be made to manipulate the fragments into position; or, in case of failure, it should be reduced by an open incision, and the fragments afterwards sutured together. In some cases it may be better to excise the smaller fragment from the joint altogether.

VII. **Compound Fractures.**—Wounds leading down to a fracture may be produced, (*a*) at the time of the injury, by the same violence that breaks the bone, or by penetration of a fragment through the soft tissues; (*b*) after the fracture, by attempts to use or move the limb, or by rough handling in removing clothes or in transport; (*c*) at a later stage, by pressure of a splint against a sharp fragment, or by ulceration or sloughing of the skin.

Healing.—If the wound be a mere puncture, and the parts unsoiled, the fracture reduced, and the wound closed at once, union takes place in much the same way as in simple fracture. If the wound is extensive, the bones shattered and loosened from periosteum, if the soft tissues and blood-vessels are much injured, and especially if the wound is septic, union is much delayed, and does not commence till progressive suppuration has stopped, dead tissues are separated, and granulations have begun to form. Provided a compound fracture can be kept aseptic, however, healing takes place as usual, but it is delayed by the disturbance of the blood-supply and loss of substance. Loose fragments of bone usually die, but if aseptic they may be surrounded by new-formed bone, and only at a later time may become a source of irritation. The immediate dangers are shock from loss of blood; the later ones are sepsis, with all its possible complications, especially pyæmia; and still later, amyloid disease.

Treatment.—If the skin is merely punctured, all bleeding being stopped, the fracture should be reduced at once. The wound is covered with sterile gauze, and the skin round it cleansed with turpentine and spirit as before an operation. The edges of the wound are then cleaned in the same way, care being taken not to rub any dirt into the opening. If bone projects, it may be replaced, but any soiled part should be cut off. The wound may be closed by suture, or left partly open and drained with iodoform gauze. If a simple fracture shows signs of becoming compound by necrosis of the soft tissues, the skin should be cleansed, bathed daily with spirit, and covered with an antiseptic dressing. If it then gives way, there is less fear of infection. In large lacerations the edges of the wound should be carefully separated, all unattached bone removed, the crushed muscles cut away, and all dirt and blood well flushed out with sterile lotion. The fragments are placed in position, sometimes fixed with wires or pegs, and the wound is firmly packed in every corner with iodoform gauze to diminish oozing and act antiseptically. Stitches may be inserted and tied temporarily with slip-knots. The part is then covered with a wadding dressing and placed in a gutter or wire splint, so that the wound is accessible for dressing without the removal of its support. In forty-eight hours the packing should be removed, and if the wound is aseptic—with no discharge, little pain, and no fever—the stitches may be tightened, a drain of iodoform gauze being left in for another forty-eight hours. If there is any discharge, the wound should be again filled with iodoform gauze, but not tightly. Of late many surgeons have reported good results from the old practice of filling the compound fracture wound with balsam of Peru, provided the injury is seen within an hour or two. The balsam forms a pasty mass invading all the interstices of the wound ; it acts as an aseptic seal to the surfaces, and to some extent antiseptically. The limb is placed in splints, and the wound covered with a light dressing.

Should the fracture be septic when the surgeon first sees it, he must treat it as other septic wounds. In addition, it should be remembered that as long as any dead bone remains in the wound it will prevent healing by the constant presence of septic products. Such wounds and foreign bodies cannot be disinfected by applying germicides, cure being effected by the tissues of the body amidst favourable circumstances. Thus, free drainage, immobilisation of the limb, and generous dietary are essential (*vide* also osteomyelitis).

Complications.—Should an *abscess* form, or a *joint* become implicated, free incisions should be made at once and the part drained. *Septicæmia* must be treated on general lines, and pyæmic abscesses opened when they are accessible. *Streptococcal* infection may be counteracted by antitoxin; and *tetanus*, which sometimes follows such fractures, may, in suspicious cases, be prevented by antitetanic serum. *Amyloid* disease, *wasting*, and *anæmia* and *bedsores* are apt to follow septic compound fractures.

Amputation is called for at the time of injury when (1) the limb is crushed beyond the hope of recovery, (2) when the blood-supply is destroyed, (3) when the patient is very feeble and wanting in recuperative powers. Other conditions may be treated expectantly, till it is seen how far recovery takes place.

Special Fractures.

Fracture of the **clavicle** is very common (15 per cent of all fractures), especially amongst children, where it is often of the green-stick variety. It results usually from indirect violence, *i.e.* falling on the hand while the arm is outstretched. In this way the bone is fractured about its middle, but direct violence may cause fracture at any point.

Symptoms.—There are pain, swelling, and loss of power to raise the arm. The sternal fragment is drawn up by the sterno-mastoid muscle, and the patient often tries to relieve this by bending the head to the injured side. The shoulder is drawn down and towards the chest, and rotated inwards by the strong pectoral muscles, and the patient usually supports the elbow with the opposite hand.

Treatment.—To reduce the displacement, the surgeon stands behind his seated patient, and, placing his knee between the shoulders, he pulls them backwards and upwards until the fragments lie in line. To keep these in place, the simplest method is to place a moderate-sized wedge-shaped pad in the axilla, raise the elbow by means of a sling, and bandage the arm to the side, with the hand placed on the opposite breast. A better method, especially for restless patients, is that of *Sayre*. Three strips of broad adhesive plaster are used. The first encircles the upper part of the humerus, passing round from within outwards, and thence round the body. This corrects the inward rotation and fixes the arm; while the second strip, starting on the sound shoulder, passes round the body, under the elbow and forearm, and is continued to the shoulder again, thus raising the arm, levering the elbow forwards, and at the same time the shoulder back, and also fixing the hand on the opposite breast. The third strip binds the arm to the body. If this is not sufficient to maintain reduction, a pad may be used in the axilla in addition. As ordinary rubber plaster is apt to irritate the skin, it is better to use that prepared with zinc oxide, and the skin should be thoroughly cleansed before applying it. Wherever the surfaces of the skin lie in contact, a layer of boracic lint should be interposed to prevent chafing. Many other forms of apparatus have been devised on similar principles, but most of them are superseded by the methods described. Should the patient be confined to bed by other injuries, no treatment is better than keeping him flat in bed, with a small pillow between the shoulders, and a bandage to keep the arm by the side; the fracture usually heals without any distortion of the parts, but from its irksomeness this method is not often available amongst ordinary patients.

The *acromial end* may be fractured *at* the coraco-clavicular ligament, when there is little displacement, or *beyond* it, when the broken fragment is turned down almost at right angles to the rest of the bone. *Treatment* in the latter case is the same as in other clavicular fractures, with a shoulder-cap outside.

The *sternal end* may be fractured, or the epiphysis separated, but both are rare.

Fracture of the **scapula** is always caused by direct violence, except partial fractures of the glenoid cavity or the neck, which are associated with dislocations of the humerus. Fracture of the body, the upper or lower angle, coracoid process, and spine are very rare; those of the acromion, neck, and head less so.

The **symptoms** are loss of complete movement, localised pain, sometimes mobility or crepitus on manipulating the fragments.

Diagnosis.—Fractures of the neck or glenoid cavity simulate dislocations, with prominence of the acromion and lengthening of the arm: but when the humerus is replaced, the deformity recurs immediately the arm is let go. The fractured part in contact with the head of the humerus may be felt in the axilla. Fractures of the acromion and coracoid process are diagnosed by manipulation, loss of power, pain, and sometimes crepitus.

Treatment.—Immobilisation of the arm, by fixing it to the side, with support to the elbow in cases of fracture of the neck, and a shoulder-cap for fractures of the acromion or coracoid process.

Of fractures of the **humerus** (7·5 per cent) those of the **shaft** are twice as common as those of either extremity.

Fractures of the upper end comprise (*a*) *intracapsular* (supra-tubercular), entirely within the capsule, (1) the *head*, (2) the *anatomical neck*, and (*b*) *extracapsular*, outside the capsule, (3) through the *epiphysial* line, and separation of the epiphysis, (4) through the *surgical neck*, (5) combinations of these, *Y*-fractures, (6) isolated separation of the greater or lesser *tuberosities*.

Symptoms.—Pain, loss of power, and sometimes great swelling. There is often but little displacement of the fragments, but by manipulations, especially with the hand in the axilla, the relation of the fragments may be detected and adjusted. *Separation of the epiphysis* sometimes resembles dislocation, with a rounded tumour presenting below the coracoid process, but it is not so smooth as the articular head of the bone, and the injury occurs in young people.

Treatment.—The axilla should be padded and a shoulder-cap of plaster-of-Paris, leather, or poroplastic bound firmly over the shoulder, with straps or bandages encircling the trunk, which fix the arm to the side, and use the chest wall as the inner splint. The hand and wrist should be suspended by a sling, but the elbow should be left free to allow the weight of the arm to take effect.

Fractures of the shaft, *i.e.* from the insertion of the pectoralis major to the origin of the supinator longus, 5 per cent of all fractures occur from direct or indirect violence, and as a rule the general symptoms are well marked. Displacement:—if the fracture is situated above the insertion of the deltoid, the upper fragment is drawn inwards by the pectoralis major, latissimus dorsi and teres major, while the lower one is drawn up by the deltoid and other muscles. If it is situated below the insertion of the deltoid, the upper fragment is tilted out by that muscle, while the lower fragment is drawn up inside by the biceps and triceps muscles. This fracture is somewhat liable to the *complications* of false joint, from the difficulty of keeping the parts at rest, and of involvement of the musculo-spiral nerve in the callus, leading to wrist-drop, as the nerve lies so close to the bone at its middle part.

Treatment.—The fracture must be set, due care being taken to reduce any rotation, noting that the external epicondyle, the greater tuberosity, and the acromion normally lie in one line. The fragments are retained in position by well-padded straight splints, or a piece of Gooch's "kettle-holder" material encircling three-quarters of the circumference of the arm, with the wood cut away where bony prominences would touch it. The hand is supported by a sling, the elbow being flexed but left free to act by its weight; and, in oblique fractures, an extra weight may be attached to the elbow to counteract any overriding of the fragments. If there is any difficulty in ensuring immobility, a rectangular splint may be used; but if made of wood it should be applied on the outside of the arm, as the fold of the axilla prevents the use of a long enough splint on the inside. Better still are rectangular splints of hoop-iron or wire, or gutter-splints of plaster-of-Paris or tin applied to the back and outer side of the limb. In fractures with much outward tilting of the upper fragment, *Middeldorpf's* triangular splint is useful; but it must be adapted to the patient, and is therefore best made of soft hoop-iron and bent to fit at the time of application.

Lower end.—In these fractures the diagnosis and treatment are often difficult. They comprise (1) *supracondylar* fractures, transverse or oblique; (2) the same with longitudinal splitting into the joint, forming *T- and Y*-fractures; (3) fracture of the *external epicondyle*, and (4) with the *condyle*; (5) fracture of the *external condyle* alone (capitellum); (6) fracture of the *internal epicondyle*, and (7) *with the internal condyle* (trochlea); (8) fracture of *both condyles*, diacondylar fracture. In examining the elbow for such fractures, it should be noted that a line joining the epicondyles passes through the point of the olecranon when the arm is fully extended; and when it is flexed to a right angle these three points form a right-angled triangle in the vertical plane.

Symptoms.—In the more common form (1), the lower fragment, carrying the forearm with it, is displaced backwards, simulating a backward dislocation of the elbow. It is reduced by pulling on the forearm, and maintained best in position by extreme flexion. Sometimes the lower fragment is displaced forwards, in so-called "flexion fractures," when the arm may be placed in a splint in the extended position. In other cases the fragments may be identified by grasping the epicondyles between the fingers, and manipulating them. The **treatment**

generally is reduction of the displacements, preferably with the help of an anæsthetic, and fixation of the arm in a rectangular splint fitted, or better, moulded to the limb. When X-rays are available the fracture should be set with the aid of the fluorescent screen. The splints, whatever their nature, should not be kept on for more than three weeks, and passive movements should then be begun. If the patient is restless, the splints may be re-applied at night. All constriction of splints or bandages must be avoided, lest the soft parts at the bend of the elbow be injured. The median nerve is liable to injury in fractures of the lower end, and the ulnar in fractures of the internal epicondyle.

If a fracture about the elbow is not properly and completely reduced, the displaced bone, in many cases, prevents full flexion of the joint, and faulty union may give rise to cubitus varus or valgus. Should mal-union take place, it is usually expedient to excise the lower part of the humerus, performing a partial excision of the joint.

Ulna.—The **olecranon** may be fractured by direct violence or by contraction of the triceps. The fracture is usually transverse in direction, and the fragments may be completely separated, or bound in place by the periosteum and tendon fibres.

The **symptoms** are localised pain, and swelling of the joint, and mobility of the separated fragment. The elbow can be flexed with some pain, but cannot be extended, except when the olecranon is still attached by fibrous tissues, and then only incompletely and with pain.

Treatment.—In the latter condition, it is sufficient to keep the arm immobilised and the hand supported by a sling, allowing free movement after three weeks. Where the fragments are widely separated the arm must be fully extended on a straight splint, a bandage being applied from the hand upwards, to prevent œdema. Should union not take place, the function may still be very good; but if this is not restored, the fragments should be united together by wire.

The **coronoid process** is sometimes broken off as a complication of backward dislocation of the elbow. There is not much displacement, as the expansion of the brachialis anticus insertion keeps the fragment in position. The **symptoms** are pain in the fold of the elbow on flexing the forearm, limitation of movement, and in rare cases crepitation. **Treatment** consists of immobilisation of the elbow at right angles for ten days or so, then free movement.

The **ulna** is not often broken except by direct violence, and diagnosis is easy, from the superficial position of the bone, the fragments being often visibly displaced.

Treatment.—Reposition of the fragments, and retention in wide splints in the semi-supine position, as in fracture of both bones.

Fracture of the ulna is sometimes complicated by a forward *dislocation of the head of the radius.* **Treatment.**—Traction is made on the forearm, to get the fracture into good position, while the elbow is flexed and pressure made on the head of the radius to force it into its normal position.

Radius.—The most common injury is splitting of the **head** and turning down of the outer or anterior fragment, which thus interferes with the bending of the elbow. The diagnosis is often difficult without the help of X-rays.

Treatment.—The best treatment is excision of the fragment, after trying the effect of 2-3 weeks' rest on a splint followed by movements.

Neck, one of the unusual varieties of fracture, arises from direct violence. **Treatment.**—Reduction of fracture and rest on a rectangular splint.

The **shaft** of the radius is sometimes broken by direct violence, and green-stick fracture of the bone is common in children. The **signs** are the general ones of fracture, but the position of the fragments is sometimes difficult to identify owing to the thickness of the overlying muscles. The line of fracture is usually transverse, and if it lies above the insertion of the pronator radii teres, the upper fragment is *supinated* by the action of the biceps; if below, it remains in the semi-supine position.

Treatment consists in reducing the fracture by pulling on the hand against the flexed elbow. The fragments are kept in position by placing the arm in supination and fixing it in a posterior angular splint.

Both bones are often broken simultaneously, generally by direct violence, and usually transversely at nearly the same level, the commonest situation being about the middle or upper third. The general signs, with mobility and displacement of the fragments, and often well-marked crepitus, make diagnosis easy, except in green-stick fractures. The forearm is often supported by the sound hand. The special danger of this fracture is the loss of power to pronate and supinate. This may occur from (*a*) bony union of all four fragments together, (*b*) union of the two fractured bones at an angle, (*c*) union of a pronated lower fragment with the supinated upper fragment.

Treatment.—The fracture must be reduced, with the bones in line and the hand rather supinated. A pair of padded splints is applied in front and behind the forearm, made wide enough to prevent the bandage from pressing on the edges of the arm and so driving the ends of the bone together. The forearm is supported in a sling and kept in the semi-supine position. If the fracture occurs above the level of the pronator teres, the limb must be kept supinated in an angular splint of iron, tin, wire, or plaster-of-Paris. The splints should be long enough to control the hand at first, but the fingers must be left free, and moved daily, to prevent stiffening. After ten days the splints may be removed temporarily, and re-applied after flexing the wrist, but they should be left off permanently in three weeks or so. Massage should be employed early, and after three weeks, movements of pronation and supination carefully carried out by the surgeon.

Pseudarthrosis may occur in these fractures, being due usually to interposition of fibrous tissues.

Fractures about the wrist joint.—**Colles' fracture.**—The bone is often (9 per cent) broken at its expansion, about half an inch above the articular surface, more especially in women and elderly people. The proper treatment of such fractures is very important, in view of the great loss of function if it is neglected.

The **cause** is almost always a fall on the hand on the thumb side, the wrist being thus forcibly extended, and the cancellous bone giving way more readily than the strong anterior ligament of the wrist joint. The line of fracture varies, but more commonly it is oblique from above downwards and towards the palm. The lower wedge-shaped fragment is driven upwards with vertical rotation of the wrist, so that the joint surface points upwards and forwards. The ulna, not entering directly into the joint, usually escapes. Less commonly, the radius is fractured by overflexion, from a fall on the bent hand; then the distortion may be reversed. Sometimes only the styloid process or a thin lamella of the surface is separated.

To **examine** the joint, the patient should be seated, facing the surgeon; both forearms should be uncovered and laid on the thighs, with the hands grasping the knees. The two wrists are now compared. The hand of the affected limb is seen pushed to the radial side; the axis of the arm is in line with the ring or the little finger; the styloid process of the ulna projects, and is found to be at the same level, or below that of the radius; the wrist at this point is increased in width. At the level of the joint there is a projection backwards, and immediately above this a depression, with a corresponding elevation in front, formed by the projecting upper fragment covered with the flexor tendons—the "dinner-fork" distortion. There is distinct localised pain at the point of the fracture, elicited by pressing with the point of the finger; mobility and crepitus are usually absent, as there is often some impaction. The hand cannot voluntarily be pronated or supinated, and the power of flexion is much diminished.

Treatment.—The essential part is reduction of the displacement. To do this the surgeon grasps the hand with his corresponding hand, and, steadying the lower part of the forearm with a firm grasp of his other hand, pulls strongly towards the ulnar side, and at the same time flexes the wrist, if necessary, using an anaesthetic. When the bones are in proper position they often remain so without any permanent fixture apparatus, except for a sling passing round the wrist just above the fracture line; but it is usually necessary to apply a couple of well-padded straight splints, the front one reaching from the bend of the elbow to the heads of the metacarpals, and the back one to the knuckles. If the displacements tend to recur after reduction, special shaped splints may be used—*Schede's* bent splint, fitted to the palmar side, to keep the wrist flexed; *Gordon's*, for much the same purpose; *Carr's*, with a wooden pad along the radial side, to raise the upper fragment, and a handle which fits into the hollow of the hand: or, a splint may be moulded of plaster-of-Paris, or other material to suit the individual case. Circular plaster or other immovable splints should not be used in forearm fractures, from the danger of interference with the blood-supply. The fingers must be left out, and moved early and often, as the tendons are apt to be fixed by adhesions in their sheaths, from injury by the sharp fragments. The limb should be massaged after a few days, the splints removed permanently in 10-15 days, and the wrist freely moved.

Fracture of the **styloid process** of the **radius** alone may be detected by manipulations. The wrist should be bandaged firmly with a circle of adhesive plaster. Union is usually fibrous. If the small fragment interferes with movements, it may be removed subsequently by operation.

Fracture of the **styloid process** of the **ulna** is treated in the same way.

Separation of the epiphysis is treated like Colles' fracture.

The **carpal** bones are generally fractured by severe crushes. Displacement of fragments is slight, but there are pain, localised tenderness and swelling, with interference of movements of the hand, chiefly from bruising of the soft parts.

The usual **treatment** is immobilisation with elastic pressure for a short time, followed by massage and free movements of the wrist.

The **metacarpals** are broken by direct violence. There is little displacement of the fragments as a rule, and that may be reduced by traction on the fingers, while the fragments are manipulated into place. The hand is fixed in the half-flexed position over a pad such as a firm roller-bandage; or better, a splint is moulded to the palmar surface.

Two short rods may be bound by adhesive tape to the back of the hand, so that they lie in the interosseous grooves on either side of the fractured bone (*Beck*).

The *thumb* is sometimes disabled by a "stave," the base of the metacarpal being fractured obliquely and the rest of the bone driven backwards, simulating a subluxation (**Bennett's fracture**). It is treated with a narrow wooden splint fitted along the inner side of the palmar surface of the wrist and thumb.

Fractures of the **phalanges**, also from direct violence, are easy to diagnose and reduce. They are best fixed with metal splints (aluminium, or tin gas-piping) fitted to the finger and carried into the palm of the hand. For the last two phalanges tubular metal splints, split down one side, are very useful. They are light and easy to remove for cleaning or readjustment.

Fractures of the femur occur in the upper end, the shaft, and the lower end.

Those of the **upper end** comprise fractures of the **head**, and **separation of the epiphysis** up to the eighteenth year, both rare injuries; fracture of the great trochanter, or in children separation at its epiphysis, also rare; and intracapsular and extracapsular fractures of the neck, which are common.

Intracapsular fractures of the neck, or fractures *at the narrow part* near the head, are common in people over fifty, and occur from falls on the hip, or from slight causes such as a stumble. Impaction may take place, by the firm bone of the neck being driven into the spongy head; and this is always to be hoped for, as otherwise the blood-supply to the separated head is cut off, and bony union cannot ensue.

Signs.—There are pain and shock; swelling over the hip, and sometimes in the inguinal fold. When the fragments are loose the leg is strongly everted; the limb is powerless and unnaturally mobile when passive movements are made; crepitus is felt on rotating the leg, and the arc of rotation is less than normal; the sharp edge of the broken neck may sometimes be felt in front of the joint; ecchymosis usually appears in Scarpa's space after a few days. On comparison of the limbs the trochanter on the injured side is seen to be displaced upwards. This is measured by *Nélaton's line*—a straight line running from the anterior superior spine of the ilium to the tuberosity of the ischium, and normally passing the highest part of the great trochanter, or by *Bryant's triangle*—formed by a line let fall perpendicularly, when the patient is lying flat, from the anterior-superior spine of the ilium, and a line ("the base") drawn at right angles to it from the upper part of the great trochanter, the triangle being completed by joining the first and last points; any displacement of the trochanter is shown by its relation to Nélaton's line, and by the length of the base in Bryant's triangle. In these fractures the deviation from normal is from $\frac{1}{2}$ to $1\frac{1}{2}$ inches. This causes shortening of the whole limb when measured from the anterior-superior spine of the ilium to the tip of the inner maleolus. The shortening relaxes the tensor vaginæ femoris, and allows the fold between the trochanter and the crest of the ilium to be easily felt, while on the sound side the tenseness of the aponeurosis makes this impossible. The trochanter is also closer to the acetabulum, owing to shortening of the neck. If impaction has occurred, many of these signs are wanting; there is no crepitus, and it should not be sought for, as very slight movements might disturb favourable impaction; the limb is not so powerless, people having been known to walk after the injury; shortening is not so great, and there is less eversion of the leg.

Extracapsular fractures, or fractures of the *base of the neck*, occur in middle-aged or younger persons. The fracture is never wholly outside the capsule, but the term *extracapsular* is convenient for classification. The line of fracture varies from the inter-trochanteric line, to one nearly perpendicular passing through the lesser trochanter. Impaction is common, the neck being driven into the great trochanter, which is thus sometimes split.

The **signs** are somewhat similar to the foregoing, with these distinctions,—the swelling and ecchymosis are more localised at the trochanter, and appear sooner; the leg is much more shortened as a rule, sometimes as much as 3½ inches; the trochanter may be flattened and widened; crepitus is fairly common; and the arc of rotation is much less.

Diagnosis from *dislocations* is usually easy, as there is in them no crepitus or free movement, and the arc of rotation is normal or apparently increased; the head of the bone also is found in an abnormal position. *Bruises* of the hip are far more likely to cause confusion; pain, swelling, ecchymosis, some eversion of the foot, and loss of power are all common to both injuries. In doubtful cases, even when there is no shortening and little eversion, the patient should be kept in bed and the limb placed between sand-bags; if there is no fracture the symptoms will soon pass off. Fracture of the *acetabulum* may give rise to similar signs, with crepitus and slight shortening; a swelling may be felt in the rectum, due to penetration of the head through the pelvic wall.

Prognosis.—The chief danger to life is from congestion of the lungs, shock, and exhaustion following bedsores. Good functional recovery cannot be expected in intracapsular fractures, but it may be looked for in the other variety if treatment is well carried out.

Treatment.—In the circumstances in which *intracapsular* fractures occur, so often in the weak and aged, the first necessity is to attend to the general health of the patient, and the second to aid in procuring repair of the bone in proper position. The patient is placed on a firm elastic mattress, preferably of horse-hair; the linen is kept carefully smoothed and frequently changed, and protection taken against bedsores. If necessary, a water-pillow, covered with a thick absorbent layer, may be used for this purpose. Old patients should not be kept lying on their backs, but should be turned at intervals on one side, and propped up in bed in a week or so, to prevent to some extent hypostatic congestion of the lungs. The fracture is treated by gentle traction on the ankle, and inward rotation of the leg. When impaction has occurred this is all that is allowable. The leg is placed between sand-pillows, or fixed in a "*long splint*" reaching from the axilla to the ankle, and prevented from twisting by a cross-piece. If there is no impaction, the treatment should not be persisted in for more than three or four weeks, and if then there is no appearance of union forming, the patient should be encouraged to get out of bed, and walk with the help of a crutch, while the hip is strengthened by a firm belt round the pelvis, and the leg supported by a *Thomas's* splint. Massage is applied daily, and in this way a false joint can be encouraged to form; while the pain and stiffness are diminished. The patient recovers some movement and power of the limb.

Extracapsular fractures are treated more vigorously, unless the fragments are impacted in good position. Healing takes place usually by bony union, often with a great amount of callus-formation, which may lead to interference with function. The shortening is reduced by traction, the leg is rotated inwards, if necessary under anæsthesia, and tension is kept up by a weight and pulley. A long splint may be used in addition, or if the shortening does not tend to recur, it may be used alone; or a plaster-of-Paris case including the pelvis applied. Union takes place in 6-12 weeks. In some cases the head of the bone has been fixed directly in place by operation, screws, pins, or wire being used for the purpose, without great success, however.

The **great trochanter** may be *fractured*, or *separated* at its *epiphysis* up to the eighteenth year, but the injury is rare. The signs are pain and swelling, localised at the trochanter, and movement of the fragments, sometimes with crepitus. There is not much interference with movements of the leg, and no shortening, but the fragment is drawn up by the glutei muscles.

Treatment.—The fragment may be fixed in place by a steel nail, or the patient may be kept in bed for three weeks or so, with a firm belt bound round the hips.

Fractures of the **shaft** are common at all ages and from all kinds of violence. The line of fracture is usually oblique, less often transverse except near the epiphysis or in rickety children, while spiral fractures are common from sudden twists of the body when the feet are fixed. The sharp ends of such fractures are very apt to penetrate the muscular tissues and so tend to produce mal-union.

The usual **signs** are present, but may escape notice owing to the thickness of the muscular tissues. There is usually shortening except when the fracture is transverse, and unnatural mobility and crepitus. In children, green-stick fractures often show none of these signs, but the bending of the bone, localised pain and swelling help diagnosis. Displacements vary with the situation of the fracture. In the upper third, the upper fragment is tilted forwards by the psoas and iliacus, and twisted slightly outwards by the glutei, while the lower fragment is drawn up behind it by the hamstrings, and inwards by the adductors, the leg being rotated outwards by the weight of the foot. In the middle third the displacements are much the same, being less marked the lower the fracture, except that the inward displacement from action of the adductors is more pronounced at the lower end. In the lower third, the gastrocnemius tilts the lower fragment backwards, while the hamstrings draw it up behind the upper fragment.

Treatment.—The fracture must be accurately set, the normal line of the leg being preserved, *i.e.* the great toe, the inner edge of the patella, and the anterior-superior spine being in one line. If the fragments are much separated by soft tissues, an anæsthetic must be used to allow of proper reduction. Most fractures of the shaft require extension, and for this purpose no apparatus is better than the weight and pulley:—the leg is well cleansed and shaved, and a broad strip of adhesive strapping is applied to each side, reaching from two inches above the knee (in order that no undue tension should be put upon the ligaments) to an inch or two above the malleoli, which are protected by a thin layer of wadding. The strapping is continued beyond this point for six inches and is attached to a cross-piece, or stirrup, of wood, wide enough to prevent the strapping from pressing on the bony prominences. A layer of bandage covers the strapping to prevent it from working loose, and a cord is attached to the stirrup, and from that led over a pulley at the end of the bed, where a weight is hung. 5 or 6 lbs. is enough for a child, but 10 to 30 lbs. must be used for a powerful adult, till the spasmodic action of the muscles subsides, when the weight may be proportionately diminished. The weight of the patient acts as counter-extension, and to ensure this the lower end of the bed is often raised on blocks. To prevent lateral displacement the limb may be steadied by sandbags on both sides, or by a "long splint," reaching from the axilla to beyond the ankle, fastened to the leg and body, with a cross-piece to prevent eversion. Small (*mediate*) splints may be applied round the fractured part, and those made of Gooch's material are most useful for the purpose. To prevent the pelvis from sinking down the mattress must be fairly hard; and if necessary it must be stiffened by placing "fracture boards" beneath it. If the antero-posterior displacements are not kept reduced by this means, a double inclined plane often effects this, by bringing the lower fragment into line with the upper one, especially in fractures of the upper third and lower end. *Macintyre's* splint is a good example of this; and *Hodgen's* another, with which extension can be applied.

In *children*, the most satisfactory way of treating fractures of the thigh is to suspend the limb by weight and pulley from a frame above the bed; lateral splints may be used in addition. Fractures treated thus heal quickly, in 4-6 weeks, and the child can easily be kept clean and dry.

Ambulatory treatment.—When there is not much displacement a plaster-of-Paris case may be applied after the swelling has gone down; or a *Thomas's* knee-splint may be worn, and the patient allowed to go about on crutches, with a patten on the other foot. The injured leg hangs free; and the limb is massaged daily.

Supra-condylar fractures of the **lower end** are usually oblique from behind downwards and forwards, and the bone may be split, forming T- or Y-fractures. The upper fragment projects in front, and the lower tilts back into the popliteal space, where the nerves and vessels may be injured. If there is splitting, the condyles move on one another with crepitus. **Treatment** in most cases is by a double inclined splint. The joint may require aspiration if there is much effusion; and the tendo Achillis may be cut if the bone cannot be tilted back into position.

Separation of the lower epiphysis may occur from 11-20 years of age, and is generally the result of great violence. The epiphysis is rotated forwards, and the upper fragment pushed downwards and back into the popliteal space, where it forms a rounded prominence. From the new position of the epiphysis, great restriction in flexing the knee will occur if the displacement is not reduced. As the periosteum is usually much torn in this injury, necrosis or even suppuration is not uncommon. **Treatment.**—The lower fragment is replaced by fully flexing the knee, if necessary, cutting the tendo Achillis to relax tension; and the leg is firmly bandaged and put upon a double inclined splint.

Part of either condyle is sometimes fractured by direct violence. The injury is diagnosed by mobility and crepitus on manipulation. **Treatment.**—Firm bandaging and rest on a splint fitted comfortably to the limb.

Patella.—The most common fractures are *transverse*, from indirect violence,—sudden contraction of the quadriceps extensor muscle while the knee is semi-flexed,—but *vertical* and *radiate* (stellate) fractures also occur from direct violence.

Signs.—There is little displacement in vertical fractures, but bruising, swelling, and crepitus are usually evident. In transverse fractures, if the aponeurotic covering is completely torn through, the fragments are separated and slightly everted, and an interval is felt between them until it is obscured by swelling. Flexion of the knee causes pain, and the patient cannot straighten the limb. These signs are less distinct if the aponeurosis is only partially torn.

Union, in vertical fractures, takes place by bony callus; but, as a rule, transverse fractures treated without operation unite by fibrous tissue. As the aponeurosis is torn through at a different level from the bone, a flap is left loose: this falls into the gap and lies between the fragments; moreover, distension by blood and synovial fluid tends to keep the fragments separate. Notwithstanding this, function is sometimes almost completely restored. The general results, however, with fibrous union are unsatisfactory; the fibrous tissue is apt to stretch and the gap widen, and the patient can no longer fully extend the knee. The muscles, too, atrophy from insufficient use.

Treatment.—The knee should be carefully disinfected and covered with antiseptic gauze, and firmly bandaged to prevent further effusion. The leg is placed in a posterior splint, and the foot raised on a pillow to relax the quadriceps muscle. If the joint is greatly distended it may be aspirated. In forty-eight hours or so, if the fragments are in good position, the bandages may be re-applied to keep the parts well adjusted, and the limb put up in plaster-of-Paris. The patient is allowed to walk about at once, and the plaster is removed in three weeks.

In all cases where the fragments remain separated, after two days' rest with pressure, they should be united by a wire or a slowly absorbable suture, which is threaded through a hole drilled in the substance of the bone, or merely tied firmly round the fragments, penetrating the ligamentum patellæ and the tendon of the quadriceps. This latter may be done subcutaneously by *Barker's* method, after rubbing the fragments together to try to dislodge interposing soft tissues :—A handled needle with a large curve is passed through the skin over the ligamentum patellæ, and under the patella, making its exit through the skin just above its upper edge. The needle is threaded with wire and withdrawn, and passed a second time through the same holes but over the patella, and the other end of the wire is pulled through ; the two ends are joined and tightened up. The small wounds are allowed to close and bury the suture. By making a curved incision, and turning up a flap, the edges of the fragments can be cleaned of fibrous tissue and blood clot, which by any subcutaneous method is only problematical. A splint is worn for the first week, then massage of the knee and limb is commenced ; after ten days the knee may be flexed ; and in a fortnight the patient may get up and walk with a crutch, while the leg is temporarily guarded by a light posterior splint. All apparatus is left off in three weeks, and only a stick used instead of a crutch.

Other methods of approximating the fragments from without by *Malgaigne's* hooks, elastic traction, etc., are valueless in procuring bony union, if any fibrous tissue lies between the surfaces.

Tibia.—The **upper** and **lower end** are occasionally fractured, with implication of the joint, or the epiphyses may be separated. The fractures are diagnosed by mobility of the fragments and widening of the joint, and treated by fixation on a splint or in plaster. The **shaft of the tibia alone** is usually broken by direct violence, and generally transversely. The fibula acts as a splint and prevents much displacement, and the injury, as a rule, is easy to diagnose.

Fracture of both bones is much more common. The tibia is broken at its weakest point about the lower third, and the fibula about its upper third. Owing to its deep position amongst muscles, the fracture of the fibula is apt to be overlooked, unless examined by X-rays. Both fractures are generally oblique, and often spiral; the lower fragment is generally drawn up behind the upper, which projects forwards.

Fracture of the **fibula** alone is common at the lower end, 1-3 inches from the tip of the malleolus. The foot is usually everted with consequent rupture of the internal lateral ligament, or tearing off of the tip of the malleolus—typical **Pott's fracture**; less commonly, the foot is turned inwards. If the bones are separated by the astragalus acting as a wedge, the tibio-fibular ligament is torn as well—**Dupuytren's fracture.**

Signs.—Fracture of the shaft of either bone is usually evident; irregularity of outline may be felt, and crepitus is often obtained. In fractures of the fibula, obscured by a mass of muscle, or by swelling, pain at the seat of fracture can be elicited by pressing the bones together at a distance. In Pott's fracture, the foot is everted, except in the rarer reverse displacements; the inner malleolus is prominent, and the heel is drawn backwards. Local pain and swelling are present at the site of the fracture, and at the inner side of the ankle-joint, but crepitus is often wanting. In the rare Dupuytren's fracture there is usually great widening of the joint.

Treatment.—The muscles should be relaxed by flexing the knee, when the fracture can be reduced by steady traction. In uncomplicated fractures of the shaft, a pair of well-padded straight splints, fastened by straps, or folded in a towel to form a "*box splint*," is very efficient to retain the fragments in position. The heel should be kept from falling back by bracing it up by a loop of bandage passing under the heel, or round the foot and fastened to the splint. Any other shaped lateral or posterior splint may be used, provided it fits well and the heel is well supported. The leg is kept raised on a pillow or laid on its side with the knee flexed, in order to keep the muscles relaxed. When the swelling has subsided, in three or four days, the limb may be encased in plaster-of-Paris, from the foot to the middle of the thigh, and the patient allowed to go about on crutches.

If there is much overriding which withstands correction, extension by weight and pulley may be used, with the patient confined to bed; or the fragments may be united by wiring or pegging. In Pott's fracture, the eversion may be kept over-corrected, bringing the lower fragment of the fibula into line with the upper, by *Dupuytren's* apparatus, viz. a thick pad on the inside of the leg, reaching from the head of the tibia to the malleolus, over which is fastened a straight splint, reaching from the knee to four inches below the sole of the foot. The foot is then inverted by bandaging it against the splints, the pad acting as a fulcrum. This is apt to be irksome, and many cases are efficiently treated by reducing the fracture and placing the leg in *Cline's*, *Roughton's*, or other similar splints, furnished with foot-pieces, the displacements being corrected by suitable paddings.

Fractures of the **tarsus** are rare, and occur from great direct violence; the os calcis is the most liable to suffer, the fragment being drawn back and up by the tendo Achillis. Diagnosis is made from mobility of fragments, and by X-rays. The best treatment is immobilisation of the foot in plaster-of-Paris.

Fractures of the **metatarsals** are treated by similar means. Fracture of the second or third metatarsals without displacement of the fragments is said to be not uncommon in young soldiers, especially in Germany. They arise from slight causes, such as "parade-marching," jumping, etc. They have been called "painful tumours of the foot," and were formerly supposed to be due to teno-synovitis; but X-rays have revealed their true nature.

DISEASES OF BONES.

Owing to the intimate relationship of bone and periosteum, their diseases will be considered together, except in so far as either may be more prominently affected.

Inflammatory Diseases.

Inflammation of bone is similar to inflammation in other tissues, but the conditions are modified by the presence of a rigid matrix in which the blood-vessels lie. The Haversian canals are unable at first to respond to any great variation in the circulation; hence a slight amount of inflammation may give rise to extreme pain from pressure of effused fluid. Soon, however, osteoclasts make their appearance, and, if active inflammation persists, there is a rapid absorption of the walls of the Haversian canals. This results, of course, in thinning and weakening of the whole bone, which in extreme cases gives rise to the condition known as **osteoporosis**.

Other forms of *atrophy* are due to senile changes, to trophic nervous influences, and to pressure of tumours, aneurysms, etc. When active inflammation subsides, the Haversian canals again adapt themselves to the size of their arteries, by regeneration of their walls by osteoblasts. Should there remain a congestion of the blood-vessels, this restoration may go on to excess, and **osteosclerosis** may result. In this case the bone is dense and sometimes eburnated, and the vessels become narrowed by encroachment of the bone substance. In addition, the osteogenetic cells of the periosteum may be proliferated, and the result is a concentric hypertrophy, or a local node (exostosis) being formed.

Periostitis.—**Simple acute** inflammation of the periosteum alone may arise from a bruise or other injury. There are pain and tenderness, some redness of the skin, and usually swelling, at first from œdema, and later from cell proliferation.

Treatment consists of rest, with elevation of the limb, cold applications in the early stages; and massage and firm pressure by bandage later.

Chronic periostitis may be due to persistence of acute periostitis, or from continuous irritation, such as strains at the insertion of muscles and ligaments, or repeated injuries. More commonly, however, it arises from specific causes, such as *syphilis*, *tubercle*, *rheumatic*, *rheumatoid*, or other diseases. There is thickening of the membrane, and beneath it a layer of new-formed bone, giving rise to nodes, spines, or general thickening, according to its amount and shape. There is pain, aching in character, and usually worse at night. The skin is not reddened, but may be œdematous.

Treatment.—Any known cause must be attended to. Potassium iodide often relieves the pain, and helps resolution of the swelling even in non-syphilitic cases.

Ostitis.—**Simple** inflammation of bone occurs from injuries, especially fractures or irritation from foreign bodies.

Infective diseases occurring in bone usually affect the periosteum, the bone and the marrow, together; and may involve the diaphysis, especially the spongy bone next the epiphysial line (spoken of as the *metaphysis*—Kocher), or the epiphysis. As a general term for inflammation of bone, *Ostitis* or *Osteitis* may be used, though **osteomyelitis** (inflammation of bone and marrow) is more usually employed. The chief infective diseases are pyogenic, and may arise from external causes, such as compound fracture, infection spreading from a deep ulcer, or from a wound; more commonly infection occurs through the blood stream (*hæmatogenous*). The most frequent agent is *staphylococcus pyogenes*, but *streptococcus pyogenes* is also common; while *bacillus typhosus*, *diplococcus pneumoniæ*, *streptococci* in connection with tonsilitis, rheumatic and scarlet fevers, have frequently been found. It is often difficult to establish the original focus of infection, but it must be borne in mind that bacteria are frequently disseminated, and localised in the bone marrow during all infective diseases. They may remain dormant for months or years, but after a slight injury they may quickly reveal themselves, by setting up local osteomyelitis. (Bloodgood.)

The exciting cause is usually slight, such as a bruise or strain; it is rarely a fracture, probably on account of the extensive effusion of blood, with its protective fluids and cells, in the latter injury. The bones most commonly attacked are the long bones, near their metaphyses; while the epiphyses, and the short and flat bones, which are the common seats of tubercle, are seldom affected.

The limitation of the disease depends on the anatomical distribution of the blood-vessels in the bone, and their involvement in the pathological process. The arteries of the long bones in the young are divided into three groups,—the diaphysial, the metaphysial on both sides of the epiphysial line, and the epiphysial vessels. The main *diaphysial* ("nutrient") artery divides into two, and extends in both directions to the epiphysial line, where it ends in terminal branches, without anastomosing with the metaphysial arteries. The *metaphysial* group of small and short vessels enter the shaft near the epiphysial line, and branch in the direction of the epiphysis, where they also end as terminal arteries. The *epiphysial* group enter the epiphysis from all sides, and run towards the bone nucleus. The older the bone becomes, the finer relatively are the arteries; and on cessation of growth at the approach of adult life, many are obliterated, while those of the joint apparatus are increased. These variations explain why infection is usually near the epiphysis, as three sets of fine terminal vessels are found there. They also explain why bone lesions are more common in infancy and youth, and joint lesions in the adult. (Lexer.)

The majority of osteomyelitic foci are due to emboli, formed of clumps of bacteria, originating in some other part of the body. If the embolus is large, the diaphysial artery may be blocked near its bifurcation, and so lead to an infective focus in the shaft, and perhaps to necrosis, from sudden interference with its blood-supply. If small, it plugs one of the terminal branches, and produces a localised focus near the epiphysis.

From the primary focus, the infection *spreads* along the medullary cavity, and outwards to the surface, stripping up the periosteum by effusion of pus, and giving all the evidences of *acute periostitis.* Occasionally, when the bone is thin, the pus perforates it and forms a *subperiosteal abscess.* This again may perforate the periosteum and form a *subcutaneous abscess.* If this bursts externally, relief is given at once, but a sinus is left, which cannot completely close as long as any discharge from the bone persists. If the abscess is situated near a joint, pus may invade it and cause arthritis. If there is an extensive thrombosis of vessels, the areas of bone supplied by them are no longer able to withstand the toxins of the bacteria, and succumb—*necrosis.* Those areas may represent the whole or part of the shaft, or merely a wedge-shaped piece near the epiphysis, according to the vessels affected.

Necrosis.—In the later stages, the dead bone separates by absorption of its periphery by osteoclasts derived from living tissues in the vicinity. If the dead piece be small it may be entirely absorbed, and the space replaced by granulation tissue, which ultimately gives way to new-formed bone. If it is large, it is merely loosened, and a barrier of granulation tissue is formed round it, and it is known as a **sequestrum.** If only the peripheral layers are necrosed, they form a scale or *exfoliation.* The continued irritation maintained by the presence of such a foreign body, often remaining infective for a long time, acts as a stimulus to the osteogenetic cells of the periosteum, and a layer of new bone is formed around it, the **involucrum.** Any opening in this or the pre-existing bone which leads down to a sequestrum is known as a **cloaca,** and is generally in close relation to a sinus in the skin. If the disease is more chronic, necrosis takes place slowly, with great absorption of the bone, leaving a mere network behind. This process is spoken of as **caries,** and may be compared with ulceration of soft tissues. It occurs especially in cancellous bone, but also affects compact bone, transforming it first into cancellous bone, and then continuing the process. **Caries sicca** is a similar kind of necrosis, occurring without visible suppuration, and is met with in tubercular disease of bone. If there is much destruction of bone near an epiphysial line, the epiphysis may be detached, *epiphysiolysis*. It is usually displaced by muscular action, but it may be maintained in place by its periosteum. In those cases bone formation is disturbed, and there is either arrestment, or at least irregularity, of the subsequent growth of the limb: and this may lead to shortening or deformity.

As long as tension is not relieved, absorption of toxins by the lymphatics is rapid, hence constitutional effects are produced early, and are severe. Further, septic clot is apt to be broken down, and carried away, to set up secondary foci elsewhere, causing septicæmia, and new infective centres.

Sometimes, in less acute cases, suppuration is confined to one spot, and a **localised** (*Brodie's*) **abscess** is formed. The reactionary inflammation causes the surrounding bone to be thickened and form a kind of capsule.

Symptoms.—**Acute Osteomyelitis** is specially a disease of infancy and youth; and it attacks more commonly the lower end of the femur, the upper and lower end of the tibia, and the upper end of the humerus. It generally begins with aching in the limb, often attributed to acute rheumatism, accompanied by symptoms of severe inflammatory type, with fever, rigors or convulsions, and delirium. The younger the patient, the sooner they appear. The limb is tender, and the least movement produces severe pain, the surface is swollen from œdema, and feels tense and elastic, but rarely fluctuant. The superficial veins are often distended, and the glands may be enlarged and tender. The skin is at first normal in colour, but later may become reddened and glazed if suppuration approaches the surface. If the focus is near a joint, it may be difficult to distinguish the swelling from effusion into it, but usually the distinction is clear. The infection sometimes spreads to the joint itself, however, and there sets up *arthritis*. Short of that, there may be synovitis with effusion (*sympathetic hydrarthrosis*), from entrance of toxins into the joint. If an incision is made over the bone, the periosteum is found to be difficult to detach, and the surface of the denuded bone bleeds. If suppuration has taken place, the periosteum is stripped up by pus; the bone is white and dead looking; and drops of pus or fat globules may exude from the surface.

Variations.—There is a very acute form, with **multiple foci.** The symptoms are very severe, and death usually occurs within a week.

Suppurative Periostitis is a mild form, in which there is only a slight involvement of the bony cortex; the main changes showing themselves chiefly in the periosteum.

Epiphysial Ostitis, a small local centre of suppuration near the joint surface, in the spots usually affected by tubercle, is comparatively rare.

Osteomyelitis Serosa, or **non-purulenta** (*quiet necrosis*), is an acute condition with a central necrosis, but without pus cells in the fluid surrounding it.

Complications. — Besides involvement of the joint, or separation of the epiphysis, fracture may occur from very slight injuries. The most serious effects, however, arise from *septicæmia*, and *secondary* suppurations. The latter occur in other joints, serous cavities, or internal organs. In osteomyelitis of the mastoid, infection may spread to the brain and its membranes. The veins, too, may be plugged with septic thrombosis, and are then a constant source of danger.

Diagnosis in early stages must be made from acute fevers, especially rheumatic. In the latter, the frequent occurrence of heart murmurs, and the transference of swelling from limb to limb, and its localisation in the joints, are characteristic. Bacteria in the pus, and a high leucocytosis, confirm the presence of osteomyelitis, while the presence of a source of infection should always raise suspicions. Cellulitis and superficial suppurations must also be distinguished.

Prognosis.—All cases of osteomyelitis are very serious, but vary much in danger with the type, and the number of suppurative foci.

Treatment.—The principles of treatment are to relieve the constitutional symptoms, and obviate, if possible, bone necrosis; and there must be no delay in carrying them out. An incision is made over the swelling along the limb, which should be rendered bloodless, and is carried down to the bone. The periosteum is incised wherever the pus is seen beneath it, and a piece of cortical bone is removed by chisel or trephine. Incision of the periosteum alone is rarely sufficient, except in superficial suppurations. In the early stage, the marrow should not be curetted, but only visible collections of pus cleared out, and the cavity lightly packed with iodoform gauze. The endosteum of the bone is not disturbed, and the rest of the bone may not necrose. If the symptoms are not quickly relieved, the whole medullary cavity should be opened up and all suppurating foci curetted. If there is joint effusion, it should be aspirated; and if the microscope shows the presence of bacteria, the joint should be opened and irrigated. In the *subacute* stage, when there is more or less necrosis, the periosteum begins to produce new-formed bone. The periosteum should then be incised along all of the necrosed bone, and stripped off it without tearing. The dead piece is then chiselled away completely, and the periosteal tube closed by suture. The soft parts are also closed, and the wound well *drained*. In this way the bone is often re-formed in its original site.

Chronic Osteomyelitis follows an acute attack, or begins of itself. In the former case, after pus obtains exit, a slow, rarefying, and at the same time osteoplastic, inflammation continues for months. The sinuses discharge thin pus, and at times particles of necrosed bone; but they may at intervals become blocked by exuberant granulations, or dried pus, when a sharp pain ensues in the bone, accompanied by feverish symptoms. Any injury may set free bacteria from the granulations, and cause local cellulitis. Meanwhile the bone becomes irregularly thickened, either at one spot, or all over. The other form often begins with a short acute stage, which may be altogether overlooked. It may not show itself for years, and then commences with aching in the bone. There is usually unnatural thickness of the bone, and this becomes more marked in one place, and an abscess may be formed in the soft tissues. It takes three forms—(1) central necrosis; (2) localised abscess; (3) sclerosing osteomyelitis, without suppuration.

Diagnosis has to be made from sarcoma, tubercle, gumma, and cysts. X-rays are of great use for this purpose.

Treatment consists in removal of sequestra (*sequestrotomy*) and suppurative centres. The limb is made bloodless; an incision is carried down to the bone, and the periosteum stripped back; a wide layer of new-formed bone is chiselled off, and the cavity laid bare. The sequestrum is removed, and the cavity scooped out with a sharp spoon. Healing takes place slowly by granulations under simple tamponade; and in order to hasten it, the wound may be closed with a flap of skin loosened from the sides; while the cavity may be filled up with blood clot, or with iodoform paste (iodoform, 60, sesame oil, 40, spermaceti, 40) (*Mosetig*), which are ultimately absorbed, and replaced by new-formed bone. For the same purpose, the periosteum may be left in contact with the cortical layer, which is chiselled off as an osteoplastic flap, and is replaced in position, after the cavity is cleared out; or a piece of living, or decalcified, bone may be engrafted.

Of **other bacterial** infections, those from streptococci, alone or *mixed* with staphylococci, as well as the less common infections from pneumococci, gonococci, or bacilli coli, are similar to the foregoing. In typhoid osteomyelitis, which occurs at the fourth to sixth week, there is a recrudescence of the fever, with swelling over a bone, most commonly a rib. After the abscess bursts, watery pus continues to flow for a long time, thus resembling a tubercular sinus. The bacillus may be found alone or mixed with others.

Osteomyelitis occurring from **external causes** runs the same course as the hæmatogenous form, but if there is sufficient drainage the initial symptoms are not so severe.

Sequels.—If a sequestrum is not removed, a persistent *sinus* remains, discharging pus, and offering a possible entrance to further pathological bacteria; or the sequestrum may travel through the tissues, and *penetrate* important structures. In some cases of chronic sinus, *epithelioma* has developed at its edges.

Deformity depends chiefly on the amount of bone destroyed, and the effect on the growing centres. If growth is arrested in one of two parallel bones, the other one has to bend, in order to find room for extension.

Relapses after long intervals sometimes occur. The infective matter either lies dormant from the previous attack, and the disease recommences from injury as in the first instance; or the bone becomes sclerosed, and its structure composed greatly of inert connective tissue, and it is unable to withstand new attacks of infective organisms which may invade its vessels. In these cases, the local effects are relatively much more pronounced.

Tubercular disease of bone or periosteum is due to infection by tubercle bacilli, derived from some pre-existing focus. It is often preceded by a slight injury. It appears most commonly in the young, but may occur at any age, even in the very old (senile tuberculosis). The favourite sites are the short bones, and the epiphysial regions of the long bones.

Pathology.—The bacilli lodging in the fine vessels set up their specific granulation nodules, either singly or in groups. These are surrounded by inflammatory tissue, and their centres gradually necrose and form caseous masses, which generally liquefy. Sometimes the disease may be confined to the periosteum, but in the great majority of cases it affects primarily the bone. The results of inflammation around the tubercles, and of the toxins secreted by them, are absorption and necrosis of the bone, so that a collection of soft curdy matter and bone particles is formed (*tubercular abscess*). The affected area may be surrounded in very chronic cases by sclerosis. One of the larger arteries is apt to be plugged, and the area of bone supplied by it necroses and forms a wedge-shaped sequestrum. The disease spreads in all directions and may appear beneath the periosteum, or may penetrate the articular cartilage of a joint, and set up *tubercular arthritis* (*q.v.*). Should the abscess burst externally, it continues to discharge as long as any sequestrum, or any of the disease, is left.

Healing, with sclerosis of the surroundings, may be expected after treatment, or, in favourable cases, without it. Recurrent attacks, however, are apt to appear after slight injuries, if the health becomes impaired. In weakly or untreated patients, destruction of the bone may proceed, and sinuses persist, with the constant danger of pyogenic infection, or of metastatic tubercular lesions occurring in the body.

Symptoms.—The onset is insidious, and the disease is generally not recognised until a cold abscess appears over the bone, or a joint becomes involved. Sometimes aching in the bone is noticed. The temperature in pure tubercular disease is only slightly raised, and is often quite normal; high fever should at once suggest pyogenic infection.

Diagnosis is usually plain on account of the typical appearance of the localities usually affected. Tubercle is often confused with chronic *pyogenic osteomyelitis*, and microscopic examination is sometimes necessary to clear up the diagnosis. Some tumours also resemble tuberculosis.

Treatment.—Small abscesses, if superficial, may be aspirated and injected with iodoform emulsion, but as a rule they should be opened, and the tubercular tissue in the soft structures as well as the bone thoroughly curetted away. The cavity may be either packed with iodoform gauze or filled with iodoform emulsion or paste, and closed by suture. If there is a sinus, its edges and walls should be dissected off if possible, and the treatment continued as above. Larger areas of necrosis must be treated as in the pyogenic form, but all visible tubercular granulations should be gouged or cut away. As soon as tubercle near a joint is diagnosed, an external opening should be made to prevent it bursting into the joint. At the same time care must be taken in curetting the cavity that the articular cartilage is not perforated.

Varieties.—In the *long bones* the disease is most frequently confined to the articular ends, and the effects are often seen in the neighbouring joints. Of the *short bones* the *phalanges* are often attacked, *Dactylitis*. Here the whole diaphysis, composed of cancellous tissue, is diseased, and may be filled with caseous matter, or with a large sequestrum, while the periosteum is greatly thickened. The soft tissues are infiltrated by the inflammation, and form a fusiform swelling. Of the *flat bones* the vertebræ are very liable to tubercle. The disease affects chiefly the anterior part of the bodies beneath the anterior common ligament. The weight of the body causes them to collapse when they become softened; this produces (*Pott's*) *curvature of the spine*, which may be followed by pressure on the cord. Along with such disease, *abscesses* extending into the *psoas* and *gluteal* regions and elsewhere are common. Tubercle in a short bone of the wrist or foot is insidious, and there often occurs a widespread infection of the articular surfaces and of the other bones before it is diagnosed.

Syphilis of bone appears as a chronic affection in the secondary or tertiary stages. At the eruptive stage, a transient periostitis is not uncommon, accompanied by severe pain, worse at night. This usually passes off when the eruption subsides, but thickening of the bone in the form of nodes or general enlargement may persist. In the late stages the bone or periosteum becomes the seat of gummata. These cause either general or local thickening of the bony tissue with increase of weight, and also absorption of bone in the immediate vicinity, and necrosis of the more central portions. The *skull* is often affected, and the result is irregular nodular thickening, with eaten-out borders; great thickening of the periosteum;

and frequently destruction of the soft parts, with exposure of the bone. Necrosis is slow, and the dead pieces take long to separate. In some parts, especially the *nose*, the disease eats away the thin bones, and the destruction is hastened if pyogenic infection occurs—a very common occurrence. Great deformity of the nose (*saddle-nose*), and hard palate remains. In the *long bones* there is either nodular thickening from periostitis, or the whole bone becomes enlarged, dense, and heavy from diffuse gummatous infiltration. The central part may caseate and give rise to the condition of *osteopsathyrosis* (brittleness), when pathological fractures readily occur. Congenital syphilis in new-born *children* sometimes affects the *epiphyses*, causing painless enlargement. Sometimes these separate, and the child is unable to move the limb (*pseudo-paralysis*).

Diagnosis.—Syphilis is distinguished from sarcoma by the history of the disease, by the effects of remedies, and by examination with X-rays. Tubercular and pyogenic infections usually affect the ends of the bones, and abscess is the rule, but either may resemble syphilis.

Treatment.—Syphilitic disease is treated by the administration of iodides, and, in the early stage, of mercury. No operative treatment is called for, except for the removal of necrosed bone, or for correction of deformities, and when secondary pyogenic infection has occurred. If there is severe pain which does not yield to medical treatment, puncture of the periosteum or bone often gives relief. The general health must be maintained by good food, fresh air, tonics, and iron.

Rickets, or *Rachitis*, though a general disease, is included among the diseases of bone, as its pathological changes are most evident in these structures. It is met with among poorer-class children, and arises from mal-nutrition, and more particularly of mal-assimilation of fat and lime salts. It is caused by improper feeding, especially with unsuitable artificial foods; from nursing on the breast for an excessive time; from bad hygiene; and from disorders of the stomach and bowels, which prevent digestion of otherwise suitable foods. It occurs early in life, from the sixth month onwards, and may persist for several years.

Pathology.—The process of ossification in the growing bones is disturbed; there is excessive formation of cartilage cells, and part of the already-formed bone is absorbed. The new tissue is irregular in arrangement, exuberant in amount, and slow in ossifying. At the epiphysial line there is much soft thickening, and the line is uneven. Microscopically, it is seen that the bone is being formed in irregular masses instead of regular trabeculæ; that there are large medullary spaces between these; and that a great number of cartilage cells persist for a long time amongst them. The periosteum is thickened, soft, and easily stripped off, and the surface left is rough from irregular deposit of bone-spicules. The whole limb is weak and soft, and is liable to green-stick fracture, to bend by exaggeration of the normal curves from pressure, and to general stunting and thickening, especially about the epiphysial ends. When the active process of the disease subsides, ossification ensues, and leads to excess of hard and compact bone.

Symptoms.—The *general* symptoms in young children are excessive sweating of the head and body, and tenderness of the bones. The child is restless and easily tired; it sleeps badly, and kicks off the bedclothes. It is often wasted, but may be fat and unhealthy-looking. The muscles are flabby, and weakness is sometimes so pronounced as to simulate paralysis. The face is pale, and there is anæmia; there is often enlargement of the spleen, and sometimes of the lymphatic glands and liver. There is diarrhœa or constipation, with pale and offensive motions. The intestines are distended with gas, making the belly large and round. The teeth are late in erupting, and often appear out of their order. In rickety children bronchial catarrh is common. Laryngismus and tetany are not infrequent.

The following are the chief **deformities**:—

Skull.—The cranial bones are deformed if rickets occurs before the second year, but not usually if it happens later. The frontal and parietal eminences are prominent, and the edges thickened; the skull is flattened and square, and the fontanelles are late in closing.

The *spine* is generally curved backwards in the dorso-lumbar region (*kyphosis*). In older children the curvature may be lateral (*scoliosis*) or forwards (*lordosis*).

Chest.—Beading of the ribs is an early symptom along the junctions of the bone and cartilage, forming the "*rickety rosary.*" There is often a broad vertical groove on each side of the sternum where the ribs and cartilages have fallen in, while the sternum is pushed forward (*pigeon-breast*). Instead of this may be a transverse groove, corresponding to the attachment of the diaphragm at the lower ribs, while the lower edge of the chest is everted.

Upper limb.—In the clavicle the curves are exaggerated, causing S-shaped deformity, and the ends are clubbed. The humerus and forearm bones may be curved, and their epiphyses are generally thickened.

The *pelvis* is sometimes narrowed antero-posteriorly by forward distortion of the sacrum, or the sides may be pressed together by the heads of the femurs in the acetabula.

Lower limb.—The neck of the femur may be bent downwards and forwards (*coxa vara*). The shafts are often curved forwards and outwards (*bow-leg*), and those of the tibia and fibula forwards, with flattening from side to side (*sabre-shaped tibia*). At the lower epiphysis of the femur, one half may be over-developed, or conversely, the other half stunted, leading to *genu valgum* (knock-knee).

Other kinds of deformity may take place according to the lines of pressure.

Treatment.—The diet must be suitable to the age of the child, and all sources of irritation to the intestinal tract avoided, and especially in the case of infants all patent foods containing starch. As a rule the best food is fresh milk quickly boiled, or used raw if warm from the cow, and given frequently in small quantities. Long sterilised or preserved milk is unsuitable. Cream and raw meat-juice may be given in addition to it. At the beginning of treatment lime-water may be added to the milk. Older children may have minced meat and potatoes, easily digested vegetable pulp, and fresh fruit-juice if not too acid. To prevent sepsis of the intestinal tract, the mouth must be kept clean by wiping it with a clean soft cloth; and if there is any thrush, borax and glycerine should be swabbed over the mucous membrane several times a day. The bowels should be kept free with grey powders, to prevent fermentation. The skin must be kept clean and dry, and the body kept warm with soft flannel clothing, and all sources of chill which might bring on bronchitis must be avoided; but there should be a plentiful supply of fresh air and sunlight. The anæmia and wasting may be treated by easily assimilated iron and cod-liver oil. The child should be kept off its feet as long as the softness of the bones continues; and, later, it may have light well-fitting supports to prevent bending of the legs. Any correction of deformities should be delayed till the active disease has ceased.

Late Rickets is a name applied to similar conditions which do not appear until after the tenth year of age. The causes are somewhat similar, viz. defects of assimilation. The chief deformities are *coxa vara* and *knock-knee*.

Scurvy is a condition which occurs in children or adults from improper diet; by a want of fresh food possessing *anti-scorbutic* properties. These are probably of the nature of ferments, and destroyed by prolonged heating. The effects of scurvy on the bones in children is a hæmorrhagic state of the vessels, causing a painful swelling about the epiphyses, in particular of the femur and tibia. Along with this occur spongy gums and anæmia. Extravasation of blood may be widespread, and may strip up the periosteum over a large area of bone. Fractures do not unite, and healing fractures may break down if scurvy supervenes.

Treatment consists in feeding with fresh meat, milk, vegetables, and fruit. In the absence of these, fruit-juice and jam may be used. Anæmia must be treated with *iron*. Local affections are treated by bandaging and application of splints.

Scurvy Rickets is a name given to a condition which is probably an acute form of scurvy, with prominent bone symptoms.

Osteomalacia (*Mollities ossium*) is a rare disease in this country. It occurs chiefly in pregnant or nursing women, but also in girls at puberty, and very rarely in men. It is due probably to some excessive vascularity affecting the bones.

Pathology.—The lime salts are to a great extent dissolved out, leaving partially decalcified bone behind. A considerable amount of absorption of the Haversian canal walls also occurs. Clinically, the disease begins with pains in the bones chiefly affected, the pelvis and femurs. As the bones soften, they become unable to bear the weight of the body; the patient becomes helpless, and deformities take place. The sides of the pelvis fall inwards, and the pubes projects forwards, thus narrowing the pelvic outlet; whilst the femurs may bend or break. The disease may remain stationary for a time, or re-ossification and cure may take place, but it is apt to progress with each pregnancy.

Treatment.—It may be arrested by stopping the suckling or the pregnancy, or by removal of the ovaries; along with general strengthening treatment with cod-liver oil and iron tonics. Sometimes no treatment appears to be able to affect it, and the patient may die from dyspnœa, owing to the softness of the ribs preventing expansion of the lungs. Deformities of bone may be prevented by suitable supports; and after ossification takes place, such deformities may be corrected by operation.

Fragilitas ossium is a condition which occurs from many causes: (1) from general diseases of bones; (2) from local inflammatory conditions; (3) from pressure of tumours, aneurysms, etc.; (4) from atrophy occurring as the result of nervous influences, either central or peripheral, of long disuse, of exhausting diseases, or senile changes in which there is great absorption of the medullary bone so that only a thin shell is left; or (5) from essential fragility, a condition met with sometimes in several members of a family, the nature of which is not known. The bones break on slight injuries; they unite readily in normal periods, but re-fracture is common.

Hypertrophy of Bone.

Osteitis deformans is an inflammatory disease of the skeleton, insidious in onset, and slow in progress, occurring in elderly people. It is characterised by a painful overgrowth of the long bones, skull, spine, and pelvis. These are softened at first, but later, hypertrophied and hardened. The first evidences are enlargement of the head and bending of the bones. The spine becomes kyphotic, and the deformity may increase until the body is bent almost double. The patient may live to an advanced age, but suffers from neuralgic pains.

Acromegaly.—A uniform enlargement of the bones, chiefly of the head, hands, and feet, associated with changes in the *pituitary body*.

Pulmonary hypertrophic osteo-arthropathy is a condition of thickening of the ends of the long bones; at first of the hands and feet, with clubbing of the fingers and toes; and later, of the long bones and spine. It is associated with many different diseases of the lungs, especially those of a chronic character.

Tumours of Bone.

Chondromata are non-malignant cartilaginous tumours arising either by overgrowth of normal cartilage, as *ecchondroses*;

or from the medullary cavity or surface of bones, as true *chondromata*. The latter are composed of hyaline cartilage surrounded by a capsule, and usually show a certain amount of ossification. They are most common on the metacarpals and phalanges, also on the feet, as multiple sessile growths. They may be completely covered with a shell of bone. Those met with in the larger bones are usually single.

Treatment —Unless they grow to a great size, or ulcerate, or interfere with function, they may be left alone; otherwise they should be completely removed with a strong knife, and all the cartilaginous material at the root scooped out. If none is left the growth does not recur.

Diagnosis.—These should be distinguished from ossifying chondro-sarcomas by their slow growth, and in doubtful cases by microscopic examination of a portion.

Osteomata are simply bony tumours which arise from cartilage or periosteum. The more common kind is the single **pedunculated exostosis**, growing from the epiphysial line. The structure is cancellous bone within a compact layer, often covered with a thin layer of hyaline cartilage. The tumour is rounded or mushroom-shaped, and has a narrow pedicle connecting it with the bone, and it is usually surrounded by a bursal sac. Its favourite seat is near the lower epiphysis of the femur. From its position it may interfere with full use of the limb, and pressure may cause pain and ulceration.

Treatment.—Where removal is necessary, the pedicle should be exposed by incision, and chiselled through its base, and the tumour shelled out. In addition, the sac may be dissected out.

Multiple exostoses, consisting of small sessile cancellous masses, are usually symmetrically distributed round the epiphysial lines of many bones. Only those which interfere with function should be removed.

Ossification of the insertion of a **tendon** may occur after strains (*vide* p. 146).

Exostoses arising from bones of membranous origin are very dense — "**ivory exostoses.**" They are found on the skull, generally on the frontal bone. They are sessile and flat, but may extend through both tables. If they give rise to intracranial disturbance they should be removed by excising a circle of bone large enough to extend into the normal bone.

Similar hard tumours are seen in the *orbit* and the *auditory* *canal.* If they give rise to trouble, they should be removed with a burr and surgical engine.

Diffuse exostosis is met with sometimes, particularly amongst negroes. It gives rise to a very hard hypertrophy of the bones of the head and face, and produces a deformity known as **leontiasis ossea.**

Fibromata are occasionally found on bones, arising from the periosteum. They are simple tumours, met with as *epulis* on the jaw underneath the gum. They are rare elsewhere.

Benign cysts of bone occur singly as a rule; but multiple cysts also are met with. The ætiology is still uncertain; but their origins are probably various. They are known to arise from (1) hydatids; (2) softening of tumours; but others (3) appear at the period of growth, often following a slight injury, and affect the bones of the extremities (*Osteo-dystrophia cystica*). They are benign throughout, and are dangerous only from their liability to cause fracture.

Diagnosis is made from solid tumours by their translucency to X-rays; and from malignant and infectious cysts by the slow growth and by microscopical examination.

Treatment.—Incision, followed by curetting and injection of iodoform.

Primary Sarcomata.

Myeloid sarcoma is a slow-growing tumour arising from the cancellous part of the bone, usually near an epiphysis. Its most frequent site is the lower end of the femur, the upper end of the tibia, and the upper and lower jaws. It commences with a boring pain, followed by swelling of the bone. As it expands, the bony wall is atrophied, until a mere shell remains. On pressing with the fingers, this may give way with a sensation of "parchment" or "egg-shell" crackling. When the tumour reaches the soft parts outside the bone, it grows more rapidly, becomes more vascular, and may give rise to pulsation. Necrosis of the skin and fungation may follow.

Diagnosis is to be made from chronic pyogenic or tubercular osteomyelitis; from syphilitic enlargements; from cysts; and from aneurysms, if there is pulsation.

Prognosis is very favourable if all the disease is removed. Metastases are slow in taking place.

Treatment.—The tumour, and a margin of half an inch all round, should be excised by knife and gouge; but if much of the bone is destroyed, it is better to resect it, or to amputate the limb. This is specially necessary if the tumour is fungating; and as lymphatic infection may have occurred, it is wise to excise the corresponding glands.

Chondro- and **Osteo-sarcomata** are round or spindle-celled tumours mixed with ossifying masses. They are more malignant than myeloid sarcomata, but less so than the following periosteal form.

Periosteal sarcoma, composed of round cells alone or mixed with spindle cells, is a rapidly-growing malignant tumour. It quickly penetrates the bone, and involves the soft parts; the blood-vessels and lymphatics are soon affected, and metastatic growths occur at a very early stage. As the tumour approaches the surface, the skin becomes thin and purplish, and eventually breaks down; and a fungating, bleeding mass of soft tissue with spicules of bone projects. It occurs mostly in young persons, apparently otherwise healthy, and its most common seat is at the lower end of the femur.

Symptoms.—The disease begins with a swelling, diffuse at first, but soon localising itself into a distinct tumour. On inquiry, a story of a previous injury may be got. There is generally not much pain at first, but its rapid growth draws attention to it. The veins over it are prominent, and the lymphatic glands may be enlarged. Cachexia comes on soon, with wasting, loss of weight, and pallor. Metastatic growths in the lungs and pleura are most common; but they may affect the spine and cause pressure, with severe neuralgia, or paralysis. There is often hæmorrhage from the tumour, and suppuration is apt to occur in it. There may be some pyrexia in the later stages, even in the absence of suppuration.

Diagnosis is sometimes difficult, as the tumour may present many confusing signs—rapid growth, fever, redness of the skin, throbbing, and heat. Osteomyelitis is excluded by its more acute onset, and by the appearance on incision; gumma, by the history of syphilis, and its reaction to iodides; and tubercle, by abscess formation or early involvement of the joint; cysts, by X-rays; and other tumours, by their history and progress.

Prognosis.—In spite of early treatment, the disease is extremely fatal, the patient in the best circumstances usually succumbing in 6-18 months. In untreated cases the patient may not live three months from the first signs.

Treatment.—Owing to the futility of any treatment at present known, diagnosis must be made most carefully, and if any grounds arise for suspecting the tumour to be other than sarcoma, suitable treatment should be tried before amputation is performed. A piece of the tumour may be excised and examined at the commencement of the operation; and if it proves to be sarcoma, the limb should be amputated forthwith, and the nearest set of glands excised. Except in this way, no *incision* should be made into such a tumour, as the liability to metastatic spread is so great. Large fungating tumours may be cauterised to render them less offensive in their later stages.

Secondary malignant growths.

Carcinoma, which never originates as a primary tumour in bone, as well as **sarcoma,** is apt to affect bones secondarily. Either may spread locally and invade neighbouring bone tissues. The *spheroidal* and *columnar* carcinomata, and *melanotic* sarcomata, are the commonest forms found in metastatic growths. They may be widely spread throughout all or any of the bones of the body. The bone expands from its centre, and may form a definite tumour or an almost uniform enlargement. The interior is soft, and the bone tissue is eaten away. Spontaneous fracture often occurs.

Treatment.—If the disease has spread locally by extension, the affected piece of bone must be removed with the rest of the tumour. If infection has spread through the blood stream, no operative treatment should be undertaken, except for palliative purposes.

CHAPTER VI.

INJURIES AND DISEASES OF JOINTS.

INJURIES OF JOINTS.

Contusions of joints may give rise to some synovitis, with effusion of synovial and serous fluid, and occasionally with hæmorrhage (*hæmarthrosis*) into the joint. The result is pain and stiffness, but if the joint is kept at rest and firmly bandaged, with massage and counter-irritation in more severe cases, recovery is usually complete. Occasionally fibrous thickening may remain, or small pieces of cartilage may be broken off, when there will be impairment of movement. Severe contusions are sometimes followed by suppuration, doubtless from infection through the blood stream; and even a slight injury is apt to be the starting-point of tubercle.

In **hæmophilia** slight bruises may cause the joint to be distended with blood. As a result, there is usually some subacute inflammation of the synovial membrane, and sometimes some organisation of the blood-clot.

Wounds of joints are specially dangerous, as absorption of septic products is very rapid from large joint surfaces. Small punctures with a *clean* instrument may be sealed with a collodion dressing; but the temperature must be noted, and at any sign of sepsis the joint must be laid open freely. In all doubtful cases, the wound should be enlarged and flushed out with sterile lotion, and packed with gauze, or drained with a tube. For complications, see *Arthritis*.

A **Sprain** is a strain of a joint, with rupture of the ligaments, either complete, or more commonly partial, and often with some injury to the soft tissues and sheaths of the adjacent tendons. There is generally much effusion of blood, which, with exudation of serous fluid, distends the joint, and causes ecchymosis and swelling. The point of injury may be identified by the pain on pressure with the finger, or by bending the joint to stretch the ligament.

Diagnosis.—In the presence of swelling, there may be difficulty in distinguishing a sprain from a fracture without displacement. The common signs of fracture are absent, but if diagnosis cannot be made by a process of exclusion, the limb should be examined by X-rays. All doubtful cases, however, should be treated at first as fractures.

Consequences.—If the effused inflammatory products are not absorbed, and especially if adhesions remain in the tendon sheaths, there may be great impairment of movement, pain and weakness. These are more common in rheumatic and gouty subjects; while tubercular disease is apt to start in the neighbouring joints in certain predisposed patients.

Treatment.—If the injury is seen at once, application of cold-water cloths frequently renewed may check hæmorrhage. In any case, the limb should be kept raised (by pillow, sling, etc.), and the joint fixed and bandaged firmly. As soon as the swelling ceases—in two or three days—the splint should be removed, massage commenced, and the bandages reapplied. Hot fomentations often give relief to the pain, but they should not be employed until hæmorrhage is no longer likely to continue. After four or five days, the joint should be moved with increasing range of movements, and the patient encouraged to use the limb soon. If the joint becomes stiff, improvement often follows forcible movements, with massage, douching, and hot-air baths.

Dislocation, or *luxation*, is displacement of the articular end of a bone from its normal position, and occurs from traumatic or pathological causes.

Traumatic dislocations are divided, like fractures, into simple and compound, and also into complete, and partial (*subluxations*), *i.e.* where the surfaces are not completely separated.

Ætiology.—Predisposing causes are weakness of the ligaments, from wasting, diseases, or previous injury; a shallow shape of certain joints, and their exposure to injury; and middle age, when the bones are relatively tougher than the ligaments. The exciting causes are violence or muscular action.

Pathology.—The end of the bone is forced through the capsule of the joint, at the same time rupturing some of the ligament fibres, and sometimes tendons, muscles, nerves, or blood-vessels. If the dislocation is reduced at once, and the joint kept at rest, the rent in the capsule heals quickly, and the irritation in the joint rapidly subsides; but if movement is allowed the bone is apt to slip in and out of the capsule, keeping open the rent till its edges become covered with smooth epithelium. In this state it will never completely heal, and the dislocation may recur at any time on slight provocation.

Signs.—There is (1) pain, and sometimes numbness from pressure on nerves; (2) inability to move the limb; (3) alteration in shape of the joint and relation of bony landmarks; (4) apparent shortening or lengthening of the limb; and (5) abnormal position of the head of the bone. These signs may be obscured by swelling, and sometimes diagnosis can be made only with the help of anæsthesia. When a fracture also is present, the dislocation is apt to be overlooked. In cases of difficulty X-rays should be used as an aid to diagnosis.

Treatment.—Reduction should be attempted by special manipulations for the several joints and dislocations, to make the bone re-enter the capsule by the same route by which it left it. The chief impediments to reduction are contraction of muscles, increasing in intensity every hour; fixation of the bone amongst tendons, muscles, or ligaments; the smallness of the rent in the capsule, and the valvular action of its edges. Muscular action, in slight obstructions, may be overcome by a sudden pull when the patient's attention is distracted, so as to take the muscles as it were unawares. In other cases a general anæsthetic should be used, as the pain is sometimes severe. The manœuvring of the end of the bone from its entanglements varies with the individual joint and the variety of the displacement. Multiplying pulleys, which were formerly used so indiscriminately, should be entirely discarded, except solely for the purpose of stretching muscles in old dislocations, and then used slowly and in the direction of the muscle fibres. The *after-treatment* consists in fixing the joint for 3 or 4 days, to allow the capsule to heal. After which, the joint should be moved in all directions but that in which the dislocation occurred: this avoids pressing on the torn part of the capsule. Douching and massage are employed daily. If reduction cannot be obtained by ordinary means, the joint may be opened, and the end of the bone levered into place. No operative interference, however, should be undertaken, except under the most favourable conditions and with full confidence in the surgeon's methods of antisepsis.

Old Dislocations.—The longer a dislocation is left unreduced, the more the impediments to reduction increase. They include adhesions of the surrounding structures; permanent shortening of the muscles; closure of the rent in the capsule behind the bone; and alteration in the shape of the articular surfaces. In old-standing cases, therefore, under anæsthesia the adhesions must first be broken down by pulling, or by tenotomy, and then manipulations begun as in recent dislocations. If the capsule is closed, or the articular surfaces much altered, such treatment is generally disappointing; and in suitable cases, reduction should be carried out through an open wound. In aged and weak patients it is sometimes better to refrain from any further treatment.

Non-reduction.—If a dislocation is not reduced, either ankylosis takes place or a new joint is formed. If the dislocated bone is firmly fixed in its new position, the surfaces are bound together by fibrous or even bony union. The muscles undergo shortening and atrophy from disuse. If there is any movement between the dislocated bones, the surfaces adapt themselves to one another, by absorption on the one hand, and inflammatory thickening to form a new socket on the other. The soft tissues also form a kind of new capsule. The movable bone generally loses its articular cartilage, and becomes eburnated and polished. The range of movement increases with use, though it seldom attains to that of the normal joint.

Compound dislocations are very liable to be infected, and should be treated from the first by the open method. The wound should be opened up, all destroyed tissue cut away, and the joint flushed out with sterile lotion. The dislocation is reduced, and the wound packed with iodoform or sterile gauze, and the limb is kept immobilised. The subsequent treatment is similar to that of a compound fracture, and an old dislocation.

Pathological dislocations occur in connection with diseases of joints, where the ligaments are weakened, or where long-continued muscular spasm has overcome them. For varieties, see *Diseases of Joints*.

Special Dislocations

Dislocation of the jaw may occur from sudden muscular action when the mouth is open. The condyle and interarticular cartilage slip in front of the articular eminence, and are held fast by the powerful muscles. The ligaments are not generally much injured.

Signs.—The mouth is wide open; the face is elongated; the chin and lower teeth project; there is a hollow in the region of the condyle; articulation and deglutition are difficult; and the saliva dribbles from the mouth. If only one side is affected, the jaw is twisted to the opposite side, and the signs are less clearly marked.

Treatment.—In recent cases the surgeon presses firmly with his thumbs downwards and backwards on the lower molar teeth, to release the condyles, and at the same time presses up the front of the chin with his little fingers. The condyles jump into place, and the teeth are snapped together; hence, if the thumbs are not well protected, they may be severely bitten. In more difficult cases corks may be placed between the last molars, and the chin levered up by a strap attached over the top of the head. A bandage is worn for a fortnight, to prevent the jaw opening beyond a degree of safety, as recurrence is not infrequent.

In old-standing cases, where ankylosis is taking place, the condyles may be excised, if other means of treatment fail.

Subluxation of the jaw is a displacement of the articular fibro-cartilage, which may slip forwards and lock the jaw for a few moments. It generally slips into its place again, but in special cases it may be necessary to suture it in place, or excise it.

Clavicle.—The **sternal end** may be dislocated forwards, backwards, or upwards (all rare). The displacement is usually obvious, and reduction is generally easily effected, by pulling back the shoulders. It is often difficult to keep the bones in position, but good results may be got from fixing an elastic pad (sponge, etc.) over the joint with adhesive plaster or bandages, and bracing the shoulders back. In backward dislocation, however, the soft structures of the neck may be damaged, and it may be necessary to excise the head of the bone to prevent injury.

Dislocation of the **outer end** (also called **dislocation of the scapula**) may be upwards or downwards on the acromion. A prominence is produced at the point of the shoulder by the end of the clavicle or the acromion. Dislocation downwards is reduced by pulling the shoulders back, and bandaging the arm to the side; displacement upwards, by raising the elbow, and fixing a pad firmly on the shoulder to keep the bones in contact. In refractory cases the end of the clavicle and the acromion may be fastened together by a wire suture.

Dislocations of the humerus are very common, being equal in number to all other dislocations together. They occur generally from indirect, less often from direct, violence, and sometimes from muscular action, notably in recurrent dislocations. There are several varieties, but most of them occurring with the arm abducted are at first *subglenoid*, the head of the humerus passing through the capsule at its lower and anterior part, where it is weakest, and lying below the glenoid head. It does not stop there, but by the leverage of the arm and muscular action moves up in front and lies below the coracoid process — *subcoracoid* dislocation, the most frequent variety. Should the violence be sufficiently strong, the head may be forced farther inwards, so as to lie below the clavicle—*subclavicular*, less common. If the head travels backwards instead of forwards, it will occupy a position on the dorsum of the scapula below the spine—*subspinous.*

Signs.—Besides pain, loss of movement, and swelling, as in most dislocations, (1) the shoulder is flattened; (2) the acromion is prominent, with (3) a depression below it; (4) the axis of the humerus is altered; (5) the head is found in an abnormal position; (6) a straight line applied to the acromion and external condyle can only touch both points when the head is not in the glenoid cavity (*Hamilton's* sign); (7) if the hand is placed on the opposite shoulder, the elbow cannot be made to touch the chest (*Dugas's* sign). Measurements of the arm and axillary folds are apt to be fallacious in these injuries.

In **subcoracoid dislocation** the head lies on the anterior surface of the neck of the scapula just below the coracoid process, and the edge of the glenoid cavity usually occupies the groove between the head and the tuberosity. The anterior muscles are tightly stretched, or they may be ruptured. The head can be felt in this position, and the elbow projects from the side and slightly backwards.

In **subglenoid dislocation**, the next most frequent, the head lies below the glenoid fossa, on the scapula and long head of the triceps. The circumflex nerve is apt to be injured, and some paralysis of the deltoid may follow. The hollow below the acromion is very marked, and the head may be felt in the axilla. The lowering of the head depresses the axillary fold considerably. In rare cases, when the muscles do not stretch or give way, the arm may be maintained abducted and upright —*luxatio erecta*.

In **subspinous dislocation** the head lies on the dorsum of the scapula. The infraspinatus muscle is often torn up, and the subscapular is usually ruptured. The elbow is pointed forwards. There is a hollow below the coracoid process, and the head is felt in its abnormal position.

Subclavicular dislocations are rare. The head is felt below the clavicle, covered by the pectoral muscles. The elbow points backwards, and the arm is kept close to the side. The shaft only of the humerus can be felt in the axilla.

Diagnosis has to be made from fractures of the neck of the humerus, and separation of the epiphysis, by the position of the head; from fracture of the scapular neck and head, by the recurrence of deformity after reduction in these cases; and from bruises with much swelling and immobility, by exclusion of characteristic signs.

Treatment. — Recent dislocations are generally easily reduced by manipulations, especially by (*A*) Kocher's method: (1) the arm is adducted until the elbow touches the side of the chest; (2) with the elbow bent, the arm is rotated outwards until marked resistance is felt: this causes the rent in the capsule to gape; (3) the adducted and rotated arm is now drawn forwards and upwards, and towards the middle line of the body: the head then begins to pass through the rent; (4) the arm is rotated inwards, the hand being carried towards the opposite shoulder: in doing so the bone slips into its place.

(*B*) Extension of the slightly abducted arm while counter-extension is made by means of a broad towel passed round the chest. The bone may be manipulated into place during extension.

(*C*) Extension with a pad in the axilla to act as a fulcrum. The surgeon may use his heel for the purpose, if the patient is laid on a mattress.

After-treatment.—The arm is bandaged to the side for 4 or 5 days, then passive movements are begun.

Complications.—Injury to the circumflex nerve; rupture of arteries or nerves, in reducing old dislocations; inflammation or suppuration, with subsequent ankylosis of the joint; recurrence of the dislocation.

Reduction of old dislocations is apt to be attended by injury to the surrounding structures; and if it cannot be carried out by manipulation without violence, the joint should be exposed, the resistant structures divided, the nerves and vessels peeled from the capsule, and the head then levered into place.

Recurrent dislocations may be relieved by exposing the capsule, and suturing the rent, after removing part of the superfluous tissue.

Elbow.—There are various forms, and in examining for these, the two elbows should be compared, and observations made as to (1) movements of one joint surface on another; (2) movements of the condyles along with the radius and ulna; (3) relation of the point of the olecranon to the condyles (*vide* p. 163); (4) rolling of the radius in its proper place.

(*a*) **Backward dislocation of both bones** is the most common variety. The elbow remains bent at an oblique angle, and the coronoid process, being locked behind the humerus, prevents further flexion. The olecranon and head of the radius, with the tense triceps muscle, produce a prominence at the back of the elbow, while the humerus bulges forwards, covered by the tense biceps, and the brachialis anticus, which is often torn. The epicondylo-olecranon triangle is abnormally lengthened. *Complications*, such as fracture of the coronoid process, the internal epicondyle, or the trochlear surface, are not uncommon.

Treatment.—The forearm is first supinated, then over-extended to release the coronoid process; traction is made on the forearm, while the lower end of the humerus is fixed; and on flexing the joint, the bones slip into place with a snap. Or, the surgeon may use his knee or other part as a fulcrum, and by traction round it may disengage the coronoid process, and allow the bones to jump into place.

(*b*) **Lateral dislocations**, generally incomplete, are fairly common. In the more usual *outward* variety the ulna rests on the capitellum, while the radius lies farther out, free from the humerus. The forearm is flexed and pronated, the joint is unusually wide, and on its outer side is felt the prominent head of the radius. In *internal* dislocations the ulna projects to the inner side of the condyle, while the head of the radius usually occupies the coronoid fossa. The forearm is flexed and semi-pronated, and the joint is widened as a whole, and the external condyle is prominent.

Treatment.—The elbow should be over-extended, and direct lateral pressure made, followed by flexion of the joint.

(*c*) **Dislocation of the radius and ulna forwards**, occurring usually from direct violence, is rare. The ligaments are all torn, and the olecranon lies on the front of the humerus. The forearm is flexed and appears lengthened, and there is prominence of the lower end of the humerus behind.

Treatment.—The joint should be acutely flexed, and the forearm thrust backwards, while the humerus is drawn forwards.

(*d*) **Dislocation of the ulna alone**, while the radius remains in position, is rare. The orbicular ligament is ruptured, and the bone is driven backwards. **Treatment** is similar to that of both bones.

(*e*) **Dislocation of the radius alone** is rather more common, sometimes occurring in connection with fracture of the ulna. The displacement is generally forwards. The head of the bone projects in front, above the capitellum. The elbow is slightly flexed, and on bending it farther, movement is checked by the humerus impinging on the displaced radius. The biceps is unduly relaxed. **Treatment.**—The elbow is flexed and strongly supinated.

A variety of this dislocation is met with in children, occurring from sudden pulls on the extended arm. A partial dislocation (*subluxation*) results, the head being pulled out of the orbicular ligament. The arm hangs down in pronation. and there is pain if supination is attempted. There is usually no obvious deformity. **Treatment.**—If the forearm is fully flexed and pronated, the radial head usually returns to its place.

(*f*) **Dislocation of one bone forwards and the other backwards** is most uncommon. The bones must be reduced separately.

After-treatment.—In all cases the joint should be fixed in an angular splint for ten days or so, but the position of the angle should be changed daily, and passive movements made at each alteration of the apparatus. If any stiffness of the joint is likely to be permanent, it is always more useful to have an elbow stiff in a bent position than straight.

Wrist and hand.—Dislocations of the **radius on the ulna**, like all other dislocations in the region of the hand, are very rare.

Dislocation of the **carpus on the radius** (wrist joint) is also very rare. Falls on the hand may displace it backwards, and a deformity resembling Colles' fracture is produced; but the prominence of the carpal bones is more rounded, and the styloid process of the radius is in its proper place, and does not move with the hand on reducing the injury. **Treatment** is generally easily carried out by extension; the hand is kept for a time on a splint, but movements are begun early.

The **carpal bones** may be dislocated singly, generally in compound injuries. They are **replaced** by direct pressure, or may be excised.

The **metacarpal bones** are sometimes dislocated by machinery accidents. **Treatment.**—Reduction by extension and manipulation.

Dislocation of phalanges, generally backwards, is rather more common, occurring from a fall, or in the case of the distal phalanges, from a cricket ball, etc. **Reduction** is carried out by extension.

Dislocation of the first **phalanx** of the **thumb** backwards on the metacarpal is of some importance. The head of the metacarpal projects through the capsule between the sesamoid bones and the two heads of the *flexor brevis*. These structures are apt to enclose the head like a button in a buttonhole, and attempts at flexion only lock the bone more firmly.

Treatment.—Reduction is accomplished by bending the thumb back till it points to the wrist, then pushing the base forwards. The soft structures are relaxed, and gape, and the head of the metacarpal retires between them into its place. In refractory cases an incision may be made, and any resistant structure divided.

Dislocation of the hip is by no means common, and only occurs from great violence, such as being struck on the back with a heavy body, or dropping on the feet with the legs in a position favourable to displacement. On account of the great depth and strength of the acetabulum, fracture of the neck of the femur is more likely to happen in the old, and dislocations are confined chiefly to the young and vigorous. The accident, as a rule, takes place with the thighs in the position of abduction. Whatever form the dislocation may take ultimately, it generally occurs primarily as a displacement of the head of the femur through the weakest point of the capsule, the lower and inner part, where also the acetabulum is shallowest. The head then rests *in the obturator foramen*, but by the great weight and leverage of the leg it is seldom allowed to remain there.. Most commonly it is carried round the margin of the acetabulum *to the dorsum of the ilium*; or in some cases it is driven *into the sciatic notch*. Should the limb be rotated outwards, the head may be displaced *on to the pubes*. These four form the most common **regular** dislocations, the less usual ones being the *anterior oblique*, the *everted dorsal*, and the *supraspinous*. In regular dislocations the Y-ligament, forming a very strong band in the front part of the capsule, limits the range of displacement, and, except in **irregular** injuries, where it is ruptured, most dislocations conform to one or other of these varieties. The ligament is attached above to the anterior inferior spine of the ilium; and below at its outer limb to the upper part, and at its inner limb to the lower part, of the intertrochanteric line. During extension and outward rotation, the ligament is tightly stretched, but slackened on flexion and inward rotation.

Classification.—Sir Astley Cooper divided them into four: (1) dislocation on to the *dorsum ilii*; (2) into the *sciatic* notch; (3) into the *obturator* foramen; (4) on to the *pubes*. Bigelow made seven divisions, the first four corresponding to the four of Cooper. They are (1) *dorsal*; (2) *dorsal below the tendon*; (3) *thyroid and downwards*; (4) *pubic and subspinous*; (5) *anterior oblique*; (6) *supraspinous*; (7) *everted dorsal*; and an 8th class of *irregular* (both limbs of the Y-ligament being torn).

1. Dislocation on to the **dorsum ilii** is the most common form. The head of the bone lies on the dorsum of the ilium, and points backwards, while the great trochanter points forwards. It passes above the tendon of the obturator internus, and strips up the glutei, and generally ruptures some of the other muscles. The Y-ligament is intact, the capsule torn at the inner and lower part, and the ligamentum teres ruptured.

Signs.—The limb is slightly flexed, adducted and rotated inwards. The knee crosses the opposite thigh at its lower end, and the toes touch the instep of the opposite foot. The head of the femur can sometimes be felt on the dorsum. The trochanter lies above Nélaton's line; the "base" of Bryant's triangle is shortened; and there is a corresponding shortening of the whole limb when it is measured from the anterior superior spine.

II. Dislocation into the **sciatic** notch. The head of the femur passes beneath the tendon of the obturator internus, and turns up behind it, till it reaches the edge of the sciatic notch. Here it remains, pointing backwards, while the trochanter looks forwards. The capsule and ligamentum teres are torn, as in the previous form, the glutei being stripped up, and the other muscles damaged. The tendon of the obturator internus forms a loop round the head of the femur, and increases the difficulty of reduction.

The **signs** are similar to those of dorsal dislocation, but less marked. There is often fair mobility, and the injury is apt to be overlooked. The shortening of the limb is much less; but if the thighs are flexed to a right angle with the body, it appears much greater, owing to the position of the head behind the acetabulum.

III. Dislocation into the **obturator** foramen. The head lies below the acetabulum, or slightly inwards, resting on the obturator externus muscle. The ligamentum teres is ruptured; but the Y-ligament remains intact, supporting the femur. The muscles are all tensely stretched, and some may be ruptured, and the obturator nerve may be injured.

Signs.—The leg is slightly flexed, abducted and rotated outwards, with the toes everted. The limb is apparently lengthened from the tilting of the pelvis, though there may be really some shortening. The body is bent forwards to relax the psoas and iliacus muscles. The adductor longus is markedly prominent as a cord, there is a deep hollow in the region of the acetabulum, and the fold of the buttock is lowered.

IV. Dislocation on to the **pubes**. If extension and outward rotation occur, the head is driven upwards and forwards under Poupart's ligament, and rests on the pubis (*pubic*), or on the pectineal eminence in front of the anterior inferior spine (*subspinous*). The head points forwards, and the psoas and iliacus muscles and the anterior crural nerve are stretched tightly over it.

Signs.—The limb is flexed, abducted and rotated outwards; it is somewhat shortened, and the head of the bone is easily felt in its abnormal position.

The other varieties are very uncommon, and, generally, are modifications of those described.

Treatment.—The bone is reduced by relaxing the Y-ligament by flexion of the thigh on the body, and manipulating the head into place through the same path by which it escaped from the capsule. The patient is laid on a mattress placed on the floor, and is anæsthetised. The pelvis must be securely held down by an assistant or by a broad strap fastened to the floor. In dislocations on to the *dorsum ilii* or the *sciatic notch*, the movements are similar. The knee is bent, the thigh flexed and slightly adducted, to loosen the head from the acetabulum ; it is then abducted, rotated outwards, and brought down beside the sound limb. In *obturator* and *pubic* dislocations, the knee is bent, the thigh flexed and slightly abducted, then rotated inwards, adducted, and brought down beside the sound leg. Shortly, it may be put, in posterior dislocations, "lift up, bend out, roll out, extend" ; in anterior dislocations, "lift up, roll in, bend in, extend" (Bigelow). The Y-ligament is put on the stretch and the head works in a circular path round the trochanter which is thus fixed. In *posterior* dislocations, it is sometimes sufficient to use extension, with the leg and thigh flexed, in fact to attempt to lift the patient off the ground by the flexed leg, while the pelvis is held down by an assistant or the surgeon's unshod foot. Traction in the extended position by pulleys can only reduce such dislocations by rupturing some of the muscles and other structures ; and it is only used with that object in view, in certain conditions, where the muscles have been allowed to shorten, more especially in congenital dislocations. It is not to be recommended in any case of recent dislocation.

In **old-standing cases**, the open method may be used, by making an incision down to the head of the bone, dividing any structures which prevent reduction, and levering the bone into its place. If this is not successful, the head may be excised : a new head is partially formed, and fair movement may be expected. In some cases of old standing, the head of the bone has formed new attachments, and good function is possible ; no operation should, of course, be done in such cases. If there is much weakness of the joint a firm belt may be worn round the pelvis. In **dislocations complicated with fracture** of the neck of the femur, it is better to expose the parts, and if possible replace the bone ; or, if not, the head should be excised.

For **congenital dislocations** of the hip, see *Deformities*.

The **patella** may be dislocated outwards, inwards, or edgeways, or, if the ligamentum patellæ is ruptured, upwards.

Knock-knee and bow-leg are predisposing causes, the exciting cause being muscular action or a blow.

Treatment.—The thigh is to be flexed on the abdomen to relax the quadriceps extensor muscle, and the leg kept straight; the patella is then pressed inwards or outwards, as the case may be, towards the centre of the joint. Where the patella is turned edgeways, it rests on one edge between the condyles, and may be difficult to replace. Pressure is exerted on the projecting edge, whilst the knee is flexed forcibly. *After-treatment.*—The knee must be kept at rest to prevent recurrence, and on account of effusion caused by the injury to the joint.

Dislocations of the **knee joint**, except from disease, are very rare. They may occur from great violence, and take place backwards, forwards, or laterally in either direction, and are often incomplete.

Signs.—In lateral displacement the condyles of the femur cause a projection on one side, and the tibia and fibula on the other. Similarly, in anterior or posterior varieties, a projection is formed in front and behind.

Reduction is accomplished by extension, with manipulations, under anæsthesia. A splint is worn for three weeks or so, and passive movements then begun, the joint being protected by a hinged splint.

Dislocation of a **semilunar cartilage of the knee**, generally the internal, occurs from a sudden twist of the joint, while the knee is partially flexed. The cartilage is nipped between the joint surfaces, and separated from its attachment to the edge of the tuberosity of the tibia. It is often broken across or split, and the free end gives rise to the so-called recurrences. At the first injury there is severe pain, with swelling and disablement; but after that has subsided there may be little sign of injury, though occasionally a projection or depression, or a loose body, may be felt at the edge of the joint. Usually the loose cartilage causes subsequent trouble, by slipping in between the surfaces and locking the joint. This is accompanied, as a rule, by a sharp stabbing pain; and some synovitis with effusion lasting for a day or two is common.

Treatment.—At first, and at each recurrence, the joint must be kept at rest till the effusion disappears. Palliative means may be taken to prevent displacements again, by fixing the knee in an apparatus which prevents twisting movements while it allows flexion and extension. If this is not efficient, or convenient, the loose cartilage should be excised. Provided strict antiseptic measures have been taken, this generally cures the condition.

Dislocations of **the ankle** are rare; lateral displacements, outwards, inwards, and also upwards, are usually accompanied by fractures of the fibula (see Pott's and Dupuytren's fractures). The backward dislocation is also rare, and the forward more so. In the last two the foot is apparently shortened, with great prominence of the heel, or lengthened with relaxation of the tendo Achillis.

Treatment.—The muscles are relaxed by flexing the leg, and the surgeon pulls strongly on the foot, and manipulates the bones, while an assistant holds the thigh. The foot is then placed on a splint with a foot-piece, and bandaged firmly. Compound dislocations are not very uncommon.

The **astragalus** alone may be dislocated, more usually forwards. It is then felt projecting in front of the ankle joint. Attempts should be made to **reduce** it by manipulations; but, failing that, the bone may be excised without much detriment to the foot. Lateral dislocations are usually compound, and easily diagnosed.

Subastragaloid Dislocations.—The foot is generally displaced backwards, and inwards, with the inversion; the sole looks inwards, while the head of the astragalus forms a prominence on the outer side of the instep. In the backward and outward variety these are reversed.

Treatment.—Reduction is made, with anæsthesia; but difficulty may arise from the tendons being caught round the head of the astragalus. *After-treatment.*—The foot is placed on a splint, and passive movement begun in three weeks.

DISEASES OF JOINTS.

Inflammation.—*Arthritis* includes diseases of all the structures of a joint—synovial membrane and capsule, ligaments, cartilage, bones, and soft parts. Inflammation confined to the synovial membrane alone is called *synovitis*. A chronic collection of fluid distending the capsule is spoken of as *hydrops articuli*, or *hydrarthrosis*; it arises from increased effusion and defective absorption, but also, to some extent, in weakly and aged patients, by passive exudation without inflammatory signs.

Simple acute synovitis occurs from bruises or similar injuries, or from the presence in the joint of loose bodies, or various irritative agents, such as gouty deposits. There is engorgement of the capillaries, and increase of synovial and serous fluid, which may coat the surface of the joint with fibrin, or give rise to fibrinous masses. Occasionally there is some hæmorrhage. The signs are like those of infective synovitis (*q.v.*), but without severe constitutional disturbance.

Treatment.—The joint is kept at rest on a splint, and bandaged firmly if the pain allows of it. Cooling lotions or ice, belladonna and glycerine, opium fomentations, or, in obstinate cases, small blisters may be applied to relieve pain; or, if the effusion is great, the fluid may be removed by aspiration. In ordinary circumstances, such inflammations subside, and leave no permanent defects. In chronic or frequently recurring cases the inflammation tends to spread beyond the limits of the synovial membrane, and there may be some permanent thickening of the capsule and synovial fringes, or hydrops may persist for a long time.

Infective inflammation occurs from wounds, compound injuries, or the entrance of unclean foreign bodies, including aspirating needles; or secondarily, by extension of infection from the soft parts or the bone, the latter especially before the age of complete ossification of the bones. Further, it may occur through the blood stream, and in this way many joints may be affected (*polyarticular* synovitis), as in rheumatism, pyæmia, etc., the particular locality being often predisposed by cold, injury, or former disease. The commonest infective agents are *pyogenic* staphylococci and streptococci, but many other microbes have been met with. The important factor in joint infection is the synovial membrane, composed of connective tissue, covered on its inner side with a layer of endothelial cells It surrounds the joint, and extends to the margins of the articular cartilage, with small fringes, which sometimes contain fat, attached to it. It is richly supplied with blood-vessels and capillaries, and a close network of lymphatics, which, however, are not in open communication with the joint. Should the synovial fluid be inoculated with any infective organism, the infection is spread rapidly all over the membrane, and excites inflammation.

Sero-fibrinous synovitis is the mildest form. It occurs in connection with non-virulent infections and general diseases, such as pneumonia, typhoid, and especially acute rheumatism.

Symptoms.—It begins in one or more joints, with swelling, tenderness, and heat, and sometimes with reddening and glazing of the skin. The limb is held rigid by reflex contraction of the muscles, and is bent in the position of least tension to the fluid in the joint; and any movement causes sharp pain. If there is much effusion the normal contour of the joint is lost, and fluctuation may be elicited. Where the effusion is slight, a general swelling of the capsule may be felt, and sometimes the thickened fringes may slip under the fingers with soft crepitation, or the surrounding tissues may be infiltrated with œdema. There is always considerable fever and constitutional disturbance.

Prognosis.—As a rule, under suitable treatment, the inflammation subsides and effusion is absorbed, without leaving any organic change. Should the effusion continue, hydrarthrosis or hypertrophy of the fringes may develop; and unnatural mobility or subluxation may ensue from stretching of the capsule and ligaments alone. If the inflammation is very severe, the joint may become stiffened by cicatrisation of fibrous tissue. Fibrinous masses also may persist as loose bodies.

Treatment.—The joint is treated as in simple synovitis. If the fluid is aspirated, opportunity should be taken to examine it by the microscope. In recurrent or chronic forms the joint may be punctured and flushed out with sterile saline or 1 per cent carbolic lotion. Early massage and movement are necessary.

Purulent arthritis may occur in two forms, one confined to the membrane (**purulent synovitis**), and the other involving all the joint structures (*panarthritis*). The former is met with as a further stage of the sero-fibrinous form; in pyogenic ostitis with spread into the joint; and in pyæmic conditions. In young children it not infrequently occurs from infection with pneumococci. The **symptoms** are similar to the foregoing form, but the conditions are much more severe; there is usually high fever, and the disease often begins with rigors.

The *more severe* inflammation, **panarthritis**, extends into the peri- and para-articular tissues, and may destroy the capsule, ligaments and cartilages, which are then replaced by granulation tissue, and cellulitis may spread into the muscular and fascial planes. The general **signs** of synovitis are present, but there is cellulitic inflammation of the neighbouring parts, and there is unusual mobility of the bones often with crepitation, or subluxation from destruction of capsule and ligaments. There is always wasting of the muscles, without much degeneration; and, as a rule, there is flexion of the limb. The special sign of destruction of cartilage is the occurrence of "*starting pains*" at night, *i.e.* when the patient drops off to sleep, the involuntary contraction of the muscles gives way, and the articular surfaces immediately grate on one another; this causes severe pain and wakens the patient at once.

Treatment of purulent inflammation consists in early incision of the joint, and flushing out with sterile lotion. Many cases treated in this way without drainage subside completely, the wound heals in a few days, and there is little or no impairment of function. Drainage tubes or gauze are apt to set up an excessive reactionary inflammation and cause formation of scar tissue, which contracts and causes stiffness afterwards. In more acute cases, the incision must be wide, and the joint should be packed with iodoform gauze frequently changed. In panarthritis all pockets of suppuration in the soft parts must be opened up and packed, and necrosed bone and cartilage curetted away. The whole joint may have to be excised; but only in cases threatening life from spreading cellulitis, or from general infection, should the limb be amputated.

Sequels.—**Recurrences** may take place after simple synovitis, especially from the presence of loose bodies, or from gout; more common in other conditions is the establishment of **chronic inflammation**, with thickening of the capsule or hydrarthrosis.

Ankylosis.—As long as the capsule is thickened there is limitation of movement, and this infiltration may become organised and lead to shrinking. Any granulation tissue formed around or between the bones may become an adhesion, and cause fibrous or, if it ossifies, bony ankylosis. With fibrous union there is little or no movement between the bones, even under anaesthesia; while in bony ankylosis there is absolute rigidity.

Treatment.—(*a*) *Preventive.*—All cases of transient inflammation should be treated by massage and passive movements as soon as the acute stage is passed. Drainage tubes or gauze should not be left in the joint; and loose cartilages or hypertrophied synovial fringes should be removed, if recurrences take place. Should ankylosis be threatened, attention must be paid to the position in which the limb is placed, so that it may be of most use to the patient if it be permanently fixed. Thus the elbow is bent to a right angle, and the knee kept straight, etc. (*b*) When fibrous adhesions have formed, they should first be broken down, by bending the joint under anaesthesia; and then active and passive movements continued till full function is restored. This may be aided by hot-air or other baths, massage, and Bier's artificial congestion.

Displacements.—**Contractures** of muscles are common, at first from reflex rigidity, and later from atrophy of non-use, and consequent shortening. The effects are usually more marked on the flexor groups of muscles, and shortening takes place at the expense of the extensors, leading to flexion of the limb.

Pathological dislocations are common after acute inflammations, in milder cases from distension and loosening of the ligaments and capsule, and in more severe cases from disorganisation of the joint structures. The contraction of the muscles draws the bones out of place, and the shortening keeps them there after the disease subsides. Should ankylosis take place after this has happened, a permanent deformity will persist.

Treatment.—In slighter cases attempts should be made to reduce the dislocation under anæsthesia, and the limb should be fixed on a splint. This may be repeated at intervals, diminishing the deformity at each treatment. The danger to adherent nerves and vessels must always be kept in mind. In dislocations with ankylosis it is often necessary to excise the joint; and if the limb has to be straightened, a large wedge must be removed also.

Atrophy of the muscles is apt to be permanent (*vide* p. 144).

Loose bodies in joints are formed (*a*) by separation of a part of a thickened synovial fringe, (*b*) or a fragment of cartilage or bone, (*c*) or by formation of fibrinous deposit, or (*d*) of fibrous development of inflammatory origin. They may give rise to no trouble, but may be felt slipping under the fingers on movements; or they may cause sudden locking of the joint. If they interfere with function, or give rise to repeated attacks of synovitis, they should be removed by an incision into the joint, first fixing them, if possible, by a needle passed through the skin.

Varieties of Arthritis.—Arthritis may occur at the height of pneumonia, especially in children, from infection with **pneumococci**; and in the later stages of **typhoid fever** from its bacillus—both are uncommon. Synovitis is the typical phenomenon of **acute rheumatism**: it very rarely goes beyond the point of serous synovitis. In ordinary cases aspiration is not called for, and only in suppuration should the joint be opened. The treatment otherwise is that of synovitis in general, and administration of salicylates and alkalies.

Gonorrhœal arthritis may occur at any stage of the urethritis, or ophthalmia, from the tenth day or so onwards, as long as the specific organisms are active in the body. It may appear as synovitis, or purulent arthritis. In the former, the gonococcus is present usually in pure culture; in the latter it may be mixed with pyogenic cocci. Many joints may be affected, or only one; in the latter case the larger joints—the knee, elbow, and ankle—are attacked.

Symptoms are those of infective arthritis in any of its phases; the suddenness of the onset with severe pain being remarkable, while the progress is apt to be chronic. It lasts from three or four weeks to several months. In the more chronic cases, permanent defects are apt to persist; and recurrences are always possible as long as the primary source of infection is not cured. Diagnosis is made sure if gonococci are observed in the aspirated effusion.

Treatment.—Rest, with fixation of the joint, is necessary as in other kinds of arthritis. In great distension the fluid should be aspirated, and, especially in suppurative cases, a 1 per cent solution of protargol or other silver preparation should be injected into the joint.

Chronic or **subacute arthritis** results from acute inflammation, or originates as a chronic disease. It is characterised by thickening of the membrane, hydrops, or ankylosis. The following are varieties of chronic arthritis.

Chronic rheumatic arthritis is the chronic form of acute rheumatism. There are slight recurring attacks which lead to thickening of the synovial membrane without much effusion. There is also little interference with movement, and when it occurs, it is due more to pain than to organic change. It is met with in the young as well as the old, and is associated with other rheumatic symptoms; and the term should be confined to such cases.

The **treatment** is that of chronic arthritis and of rheumatism.

Gout is a disease characterised by acute and chronic arthritis, depending mainly on the deposit of urate of soda in the articular cartilages and ligaments. The first attacks are usually acute, and commence with sharp and severe pain in the metatarso-phalangeal joint of the great toe, which becomes swollen and red, accompanied by fever. The symptoms subside, but may return at intervals of a day or two, until the attack as a whole passes off. Suppuration practically never occurs. There are sometimes internal complications ("*suppressed gout*"), with gastro-intestinal, cardiac or cerebral symptoms, possibly of uræmic origin. The more pronounced lesions in the joints are thickening from chronic inflammation, and uratic deposits which may be so great in amount that they distend the skin, and break through, appearing as "*chalk stones.*" Each acute attack increases the stiffness and deformity.

The chief **treatment** is regulation of diet and personal hygiene; the use of lithia, and potass salts, and colchicum, and periodical visits to spas. Surgical interference is not called for.

Osteo-arthritis (including in the term *arthritis deformans*, *rheumatoid arthritis*, *rheumatic gout*, and many other ill-defined chronic conditions). There is swelling of the affected joint, with little or no fever or pain. The disease attacks joint after joint, and the lesions are often symmetrical, the fingers and wrists being chiefly affected. The synovial membrane first is inflamed, and osteophytic overgrowths appear at the reflexion of the capsule, by hypertrophy of the cartilage, or development from the periosteum. These cause great deformities, and in the fingers give rise to *Heberden's nodes.* The articular cartilage becomes denuded, and the surface of the bone exposed. The opposing surfaces of the bone, by rubbing and chronic inflammatory thickening, become very hard (*eburnated*), smooth and polished, and, in hinge joints, marked with parallel grooves. As the bony outgrowths increase at the edges of the joint, movements become more and more restricted, and may ultimately be abolished. There is generally some atrophy of the muscles; and contractures are not uncommon, and tend to increase the deformities. The disease is acute or subacute in children and young adults, and rapid in progress, but amenable to treatment if taken in hand early; in older people it is chronic and very resistant to all treatment.

Diagnosis is made from gout and rheumatism by the lipping of the cartilage, the outgrowths of bone, and the grating of the surfaces; the absence of result from the use of salicylates; and improvement under generous diet.

Treatment.—General strengthening treatment is essential—*i.e.* nourishing and stimulating food, fresh air and exercise, iron and cod-liver oil. Surgically, the joints may be treated by passive movements, not by fixation; and massage and hot-air baths are often efficacious. The waters of various spas are also of help.

Nervous Joint Affections.—The joints sometimes suffer from want of trophic influence. This is specially noticed in regard to interference with the sensory tracts. Here it is supposed that the reflex vasomotor changes induced by the afferent nerves are disturbed. Thus in lesions of the peripheral nerves the joints share in the general atrophy and weakness of the part towards external injuries.

Charcot's Disease (*tabetic arthropathy*).—In *locomotor ataxy* the joints of the lower limb, especially the knee and hip, are sometimes affected with painless swelling and distension with fluid, loosening of the ligaments, and wasting of the ends of the bones. This permits of great mobility of the joint, and the ends of the bones are easily displaced (*pathological dislocation*). If the effusion subsides, the displacement generally becomes permanent by shrinking of the soft tissues, and fibrous or bony ankylosis is apt to take place. Sometimes there is great development of new bone at the margins of the capsule, and this leads to further deformity, and in the more mobile joints may prevent reduction of the displacements.

Similar lesions are met with in the course of *syringomyelia*, but they are less commonly symmetrical.

Diagnosis is made from its marked painlessness, and from the other signs of *tabes*.

"**Hysterical joint**" is a condition in which the symptoms resemble those of any other chronic joint affection. It occurs in neurotic women, but sometimes in men; and the subjective symptoms are generally more severe than the appearances of the local conditions would seem to warrant. Pain in the joint and sensitiveness of the skin are complained of, and light touching elicits it as well as deep pressure. The joint may be maintained in one position for so long, that shrinking of the soft parts may produce a pseudo-ankylosis, which, however, usually disappears under anaesthesia.

Diagnosis, which is often difficult, is made by elimination of other diseases, and by the use of X-rays.

Treatment consists in general attention to the health, and sometimes Weir Mitchell's special treatment is of use. Locally, movements and massage, hot-air baths and electricity are of use; but all splints or fixation apparatus are to be avoided.

Tuberculosis of joints occurs either by a primary infection of the synovial membrane, the most common method in adults, or secondarily from rupture of a tuberculous focus of the adjoining bone, by far the most usual way in children. It is notably a disease of childhood and youth, but it is met with at any age, and affects old people also—*senile tuberculosis*. The joints most liable are the hip and spine, which are very often attacked in children, next the knee and elbow, while disease of the wrist and shoulder are more common in adults.

Pathology.—By whatever means the tubercle bacilli gain entrance to the joint, they develop on its surface what are practically *miliary tubercles*, spreading over the whole joint, except in so far as it is limited by previous adhesions. The reactive inflammation and degeneration give rise to the typical phenomena of tuberculosis of joints, *i.e.* exudation, granulations, and secondary changes in cartilage and bone. The *exudation* in the early stages, and throughout in mild cases, is serous, and sometimes gives rise to *hydrops*. In most cases it becomes sero-fibrinous, and the surfaces are covered with flakes of fibrin. Movements of the joint frequently cause these to assume the shape of melon seeds or rice grains; they are translucent masses, which often contain tubercle bacilli, and either lie free in the joint or are attached to the synovial membrane by stalks. Only in very severe cases is the exudation *purulent*. The *granulations* appear first on the synovial membrane, but tend to fill up the joint cavity, and spread over the articular cartilages. If cicatrisation takes place early, a moderate thickening of the membrane remains, with little sero-fibrinous effusion, and the *dry* or *fibrous* form is established, in which there is little tendency to caseation or suppuration. Should the disease progress, the joint becomes rapidly disorganised, by implication of ligaments, cartilage and underlying bones. The synovial membrane is studded with thick, pulpy granulations, buried among which are numerous caseous nodules, or abscesses. If these empty into the joint cavity, they give rise to *tubercular suppurative arthritis.*

The *articular cartilage* itself is never the seat of tuberculosis, but it becomes destroyed by the corroding action of the granulations, which cause first a deep pitting, then perforation ; the same results occur on the under surface from a tubercular focus in the epiphysis. This is spoken of as *ulceration of cartilage,* though it is more correctly described as *degeneration.*

Further, in primary synovial tuberculosis, the toxins produced in the joint have a peculiar influence on the cancellous bone beyond the cartilage, setting up a simple inflammation, which causes *porosis* by absorption of some of the trabeculæ (cf. *sympathetic hydrarthrosis,* p. 181). The cartilage may be loosened from its bone, or may also be broken up into pieces by degeneration. Should the tubercular granulation tissue be slight in amount, slow in developing, and early in cicatrising, large pieces of cartilage and bone may become destroyed without any sign of suppuration—*caries sicca.*

Besides these effects, the other tissues in the vicinity suffer from chronic inflammatory changes. The ligaments, tendons, and soft parts are infiltrated with œdema, and the connective tissue and fat are replaced to some extent by soft gelatinous granulations. The whole forms a spindle-shaped mass, covered with pale glazed skin, and is known as *white swelling* (*tumor albus*). This is made more prominent by the *wasting of the muscles* above and below, which always takes place, partly from disuse, and partly from trophic changes in connection with the reflex rigidity of the joint.

There may be some *overgrowth of bone* at the edges of the joint from excessive stimulation of the periosteum.

Pathological dislocations and *contractures* may occur as in other forms of arthritis ; and suppuration and abscess may lead to the formation of *fistulæ.*

The **clinical phenomena** are so varied in the different forms and different joints that no single description can express the appearances. In general, however, the disease commences very insidiously, and its course is chronic, except sometimes in infants, where it may assume an acute form. The first symptoms are weariness and weakness of the limb, and there is often a story of some previous injury. The discomfort diminishes on resting the limb, but increases on exertion.

When the disease originates in a focus in bone, there is sometimes dull pain, which is widely distributed ; but it becomes more localised, and is sometimes attended by fever when the joint becomes affected. Once the disease is established there is swelling from thickening of the capsule, œdema, or effusion ; there is interference with function, *i.e.* stiffness on making full movement, or limping in the case of the lower limb. As it progresses, the range of movement becomes less, until the joint remains fixed, in the position of most ease, by reflex contraction of the muscles. This often gives rise to a characteristic attitude, which, however, can be made to disappear under anæsthesia.

In the milder form there is either "*dry*" *thickening* of the membrane, with fibrinous effusion, which may give rise to soft crepitation when pressed by the finger, or *hydrops articuli*. In this stage it may be mistaken for simple synovitis or hydrops. The swelling may diminish, and there may be complete cure, with little organic change. It is often, however, a precursor of the more common *granulating form*. This is characterised by the development of "white swelling," with obliteration of the normal contour of the joint, and great wasting of the muscles. The swelling may be mistaken for *sarcoma* or *periosteal gumma* from its elastic consistence, or for *epiphysitis* or *hæmarthrosis* from its occasional softness and pseudo-fluctuation. If the inflammation subsides, healing may be brought about, but cicatrisation of the granulations will give rise to stiffness ; and, if care is not taken to prevent them by use of suitable splints, to contractures or subluxations. If, on the other hand, caseation or liquefaction occurs, it leads to disorganisation of the joint, and sometimes to abscess and fistula, often with considerable constitutional disturbance. Pathological dislocations are not uncommon.

A rarer form of primary tubercular synovitis occurs with early suppuration in the joint (*tubercular empyema*). It is very chronic in character, and causes few symptoms. In the absence of pain and pyrexia, it may be mistaken for simple hydrarthrosis. It often progresses to abscess in the soft parts, and fistula-formation.

Prognosis depends greatly on the patient's general strength, age, and powers of resistance to general infection. The chief causes of death are exhaustion and amyloid disease, general pyogenic infection from contamination of a tubercular sinus or fistula (*hectic fever*), or tubercle of internal organs. Up to the age of twenty or so, cure by conservative measures is more likely to take place; in adults, operative treatment is more generally called for; but in all cases recovery is slow. Other tubercular lesions are not of themselves any bar to operation; indeed, the general condition of a patient suffering from phthisis is often appreciably improved by the removal of a large tubercular focus. In such cases, however, it is better to amputate than to draw upon the patient's vitality for recovery after a conservative operation.

When recovery takes place, the function of a joint is seldom fully restored. There is nearly always some stiffness left, and often considerable ankylosis. Further, the cure may be only apparent, as the remnants of the disease may remain in the joint, and may be lighted up into an acute form after a slight injury.

Treatment.—In addition to *general* treatment by fresh air and generous diet, *local* treatment is required. Owing to the tendency towards spontaneous cure in many forms of tuberculosis of joints, treatment should be in the first instance *conservative*, the object being to retain the joint apparatus, with mobility if possible, but failing this, with fixation in a position most suitable for subsequent usefulness. To attain this, the joint must be given *complete rest* by immobilisation, with control of the muscles above and below it. The simplest method is to encase the limb in plaster-of-Paris, carefully adapted over a thin flannel bandage or stocking; a certain amount of pressure in addition is thus exercised, and helps absorption. If there is any discharging sinus, a window must be left in the plaster case, and the wound should be dressed frequently, in order to prevent soiling and softening of the plaster. The apparatus must be renewed every 6-10 weeks, and opportunity should be taken to cleanse the skin and dust it with boracic powder to prevent eczema. In some cases well-fitted splints may with advantage be substituted for the plaster. This treatment should be continued till the swelling has subsided, and the limb can bear movements or pressure without pain or occurrence of pyrexia, when the apparatus may be left off.

If *contracture* in a faulty position is already established, it may be corrected in the early stages by extension with weight and pulley, or by gradual bending under anæsthesia, the limb being afterwards placed on a splint until it is ready for plaster. This may be repeated in a few days, and the deformity corrected a little more on each occasion. Tubercular foci in the bone are apt to be ruptured if adhesions are *forcibly* broken down, and the disease may be re-awakened, or general tubercular infection set up; correction of fibrous or bony ankylosis, therefore, if it is required, is better attained by an operation.

The process of healing may be aided by *Bier's artificial congestion* for 1-2 hours each day, with a bandage applied firmly over the lower part of the limb to prevent unnecessary œdema, the limb being kept meanwhile on a splint. *Counter-irritation* with iodine, blisters, etc., is generally of little value; but in cases with destruction of cartilage, great *relief from pain* is often experienced after the actual cautery is applied to the skin over the joint.

In addition, *iodoform* in an emulsion of glycerine or oil (5-20 c.cm.) may be injected into the joint after aspirating the effusion, or into the tissues surrounding it. The injection may be repeated in ten days or so. The temperature usually rises slightly after each injection, but it falls in 24 hours. Should the fever persist, or any harmful effect be noted, the injections should be stopped.

Treatment in this way often takes long to effect a cure, but it should be persisted with in all recent cases, and it should be tried for a time in old-standing cases, which show no tendency to rapid progress of the disease. If the local conditions become worse, further measures are called for. Cases complicated with sinuses contaminated by pyogenic microbes, or with disease of the lungs or kidneys, are not generally suitable for conservative treatment.

Operative treatment consists in opening the joint by means of a free incision, so as to give exit to pus and expose the whole surface; and in removing all the diseased synovial membrane by the knife, scissors, and sharp spoon (*arthrectomy*), the raw surfaces being sometimes rubbed with iodoform. The wound is closed, but drainage should be employed for the first few days. If the cartilage and bones are affected, the articular ends of the bones must be removed (*excision* or *resection* of a joint), and any deep-lying focus of disease in the bone scraped out. The details of the operation vary with the subsequent requirements of the limb; thus in the knee, bony ankylosis is best, while at the elbow the aim is a mobile joint.

Syphilis of joints is rare, but in the eruptive stage there is sometimes *arthralgia* and *synovitis*, which pass off under anti-syphilitic treatment, or on subsidence of the disease. In the later stages, a bone may be the seat of a gumma, which becomes softened and penetrates the neighbouring joint, and gives rise to arthritis. There is also a form of joint swelling in children affected with inherited syphilis, in which there is epiphysitis, with concomitant synovitis of the joint near it.

Diagnosis is made chiefly from other syphilitic signs; from the implication of several joints; and, in general, from the mildness of the symptoms.

Treatment is antisyphilitic, with surgical correction in cases of deformity.

"**Still's disease**," for want of a better name, is applied to a chronic progressive enlargement of the joints, associated with general enlargement of the glands and spleen, which occurs in children, usually before the second dentition. It is insidious in onset and commences with stiffness and enlargement of the joints, which become affected one after the other, and symmetrically on either side. There is no bony overgrowth or lipping of the articular ends of the bones, but there is a general thickening of the tissues around the joints. There is no tendency to suppuration or ankylosis, but muscular wasting occurs early. The concomitant enlargement of the glands is notable, being moderate in extent, and rather hard in character. The glands remain separate, and have little tendency to break down. The course is slow, and the treatment is general attention to the bodily functions.

Diseases of special Joints.

The **sterno-clavicular** joint is rarely affected, except by pyogenic (metastatic) or rheumatic synovitis.

Shoulder.—Acute or chronic *rheumatism* is very common. *Ankylosis* is apt to occur after injuries. It is often obscured on account of the free mobility of the scapula, and it is difficult to treat. Excision of the joint is sometimes necessary to get free movement.

Tubercular disease may arise in connection with disease of the epiphysis of the humerus, less commonly of the glenoid region of the scapula. It is distinguished by swelling along the line of the biceps tendon, or by protrusion behind and below the joint. There is atrophy of the deltoid and scapular muscles, and extensive ankylosis.

Diagnosis.—*Paralysis* of the deltoid from injury of the circumflex nerve, *arthritis deformans*, or *sarcoma* may be mistaken for it.

Treatment.—Incision is made over the front or the outside of the head of the humerus, and arthrectomy, or excision of the head performed, followed as much as possible by mobilisation.

Elbow.—*Ankylosis* is a frequent result of injury, especially of fractures of the humerus involving the joints. *Tuberculosis* usually commences as a synovitis, generally affecting the whole joint, but sometimes confined to the radial or ulnar portion. There is often great atrophy of the muscles, and "white swelling."

Treatment.—In milder cases, fixation with the elbow at a right angle or a little less, as the position most suitable if ankylosis ensues, is the first treatment. Later, if the disease progresses, the joint should be excised; the lower end of the humerus, at all events, being removed to allow for cicatricial contraction. The radio-ulnar joint may be left if it is not much diseased. Movements to the full natural extent should be begun as soon as the wound is healed.

Wrist.—In *tubercular disease* the chief danger is involvement of the tendon sheaths, with loss of movement of the fingers.

Treatment.—The joint is first encased in plaster, but the fingers are left out, and should be moved daily to prevent fixation. In the later stages the wrist joint must be excised.

Sacro-iliac Disease.—*Tuberculosis* sometimes affects the sacro-iliac synchondrosis in children and young adults. It gives rise to pain on walking, on contraction of the abdominal muscles, and on pressure inwards on the iliac crests. The patient complains also of weakness, and sometimes looseness of the pelvis. There may be apparent lengthening of the leg from tilting of the pelvis, and sometimes flexion of the thigh, from irritation of the psoas muscle. If abscess forms, it usually points posteriorly, less commonly into the iliac fossa.

Treatment.—The pelvis and thigh must be fixed rigidly in a plaster casing, or with a moulded splint. If the symptoms do not subside rapidly, an incision should be made over the joint, and all the diseased parts cut and chiselled away.

Hip-joint Disease (*morbus coxæ; tubercular coxitis*).—*Tuberculosis* of the hip joint is specially a disease of childhood, the most critical age being from the 5th to the 10th year; it rarely commences after puberty. It may originate in the end of the femur or the acetabulum, in about equal proportions, or less commonly in the synovial membrane. In the femur there may be an isolated focus, and a single wedge-shaped sequestrum; or multiple foci, and the epiphysis of the whole head may separate. Pressure on the bones usually causes atrophy, and if the acetabulum is the primary seat of disease, this pressure may cause excavation of the upper edge, giving rise to the so-called "*wandering acetabulum*"; and dislocation of the femur may readily take place. If tubercular suppuration occurs, there may be no signs of it but a little fulness in front of the joint, as long as the pus is encapsuled; but on escaping from the capsule, the abscess may point below Poupart's ligament outside or inside the femoral vessels, or posteriorly in the gluteal region; or it may penetrate the acetabulum, and enter the pelvis, and escape by the bladder or bowel, or point in the perineum, septic infection being common in these latter circumstances. Diffusion of tubercular matter into the surrounding tissues is usually accompanied by a little fever.

Symptoms.—The *earliest signs* are limping and pain. The leg is dragged along or swung by moving the pelvis; it is slightly flexed at the hip, and abducted—the position of least tension on the fluid; the foot is everted, and the weight rests on the toes. The tilting of the pelvis, to compensate for this, gives rise to lateral bending of the spine (*scoliosis*), and to apparent lengthening of the leg which measurements do not confirm. The pain may be elicited by direct pressure inwards on the trochanters, or on the heel or knee; the chief pain, however, is excited by movements to overcome the reflex rigidity of the muscles: thus forcible abduction and adduction, flexion, and rotation at once call it out. The pain is sometimes referred to the inner side of the knee, by implication of the *obturator nerve*; and this may cause confusion in diagnosis, in the absence of other signs of hip-joint disease. The rigidity, which is an early sign, along with flexion, causes acute arching (*lordosis*) of the lumbar region of the spine, when the child is placed on his back on a table and the leg extended; on flexing the leg on the body, the pelvis moves with it, and the lordosis at once disappears. At the same early time, the muscles show signs of wasting, the most noticeable instance being the flattening of the buttock, with obliteration of the gluteal fold. If there is much effusion, it may be felt as fulness in the groin. In the *later stages* these signs become more pronounced. With destruction of the cartilage, "starting pains" come on; and the muscle atrophy is greater. Yielding of the ligaments and tendons alters the attitude, and the leg becomes flexed, adducted, and inverted. This is aided by the position taken up in bed, when the patient lies on the sound leg, and the other falls over it; and by the use of crutches, where this position helps to keep the foot off the ground. The result is apparent shortening; but with much erosion of the bone, real shortening takes place, and the trochanter may take up a position above Nélaton's line. Spread of the disease may cause "white swelling" of the hip, and in still later stages, abscess- and sinus-formation, often followed by pyogenic infection and hectic fever.

Diagnosis may be difficult, if the signs are not well marked. The conditions most likely to be confused with tuberculosis of the hip are:—

Growing pains: which are not increased by movements, and subside with rest.

Rheumatism: the pain flitting, and generally subdued by salicylates, and other signs of rheumatism being present, such as heart lesions, chorea, etc.

Sciatica and *neuralgia*: rare in children in the absence of some pressure cause, such as injury or tumour.

Hysterical joint, simulating in many ways tubercle of the hip: but generally not completely, movements being often possible, while the patient's attention is distracted.

Acute synovitis and *osteomyelitis*: more acute, with fever and severe constitutional disturbance.

Sacro-iliac disease: the pain not being increased by movements of the joint.

Fracture and *dislocation* with effusion and swelling, but no history of accident: the swelling subsiding and allowing diagnosis of the injury to be made.

Appendicitis with pain referred to the hip, and increased on extension of the thigh by dragging on the psoas and iliacus muscles: but not increased by flexion or rotation.

Inflamed glands in the groin: the pain diminishing or not increased, on relaxation of the tissues by flexing the thigh.

Congenital dislocation of the hip, and *coxa vara*, with displacement upwards of the trochanter: the former, showing great mobility; the latter, free adduction; and both, no pain on pressure.

Infantile paralysis, with impaired mobility from atrophy of the muscles: but no pain on pressure.

Psoas abscess, when fairly acute: the pain being generally confined to the back, and other signs of spinal curvature being present, while the joint is movable, except in some degree on account of the swelling.

Sarcoma near the joint, with swelling and pain, is sometimes difficult to diagnose: but its growth is more rapid.

Charcot's disease and *arthritis deformans*: unusual at the age when hip-joint disease is prevalent.

Prognosis in tuberculosis of the hip is somewhat unfavourable; but in more recent years, with conservative treatment at an early stage, the results are rather better than formerly. The best results are obtained in children up to 5 years of age; after 20, the prospects of cure are not good. The general mortality is unfortunately high; death occurring from tubercle of internal organs, or from complications. In any case the course is slow, and it is often a matter of several years till cure is effected. The after-results of successful treatment consist of complete cure with mobility; or more often, subsidence of the disease, with shortening of the limb from destruction of bone, and with ankylosis, which is usually fibrous but fairly complete, and rarely bony. If care is not taken, there is apt to be much deformity, fixation of the leg in bad position, and curvature of the spine (lordosis and scoliosis) to compensate for shortening and flexion.

Treatment.—The local treatment should at first be conservative, and for this *complete rest* is necessary. The patient should be kept in bed till pain or rise of temperature are no longer excited by gentle movements or pressure; while traction is made on the leg by weight and pulley. The weight must be just enough (6-12 lbs. in children) to prevent the muscles from contracting and producing "starting pains." Very slight separation of the bones will prevent them from rubbing on one another, and healing takes place much more rapidly than when they are in contact. The direction of traction should be that of extension of the thigh and a little abduction. If the thigh is already in a bad position, it is better to correct it gradually, by first adapting the direction of traction to that of the limb, and altering it a little every day, until a suitable position is reached. In resistant cases, tenotomy may be employed to release contracted tendons and ligaments; but no violence should ever be used. In the case of young children, this extension may be carried out by using a double long splint joined together by cross-bars, and reaching on each side from the axilla to beyond the sole; such a splint as *Bryant's* is specially useful, as there is a movable foot-piece with a mechanism for extension. The child is fastened in this apparatus, and body and thighs remain fixed in one rigid piece. This prevents him from rolling about in bed, and permits the nurse to keep the parts about the perineum clean and dry with ease. In addition, it allows him to be carried out into the fresh air, a matter of great moment.

Counter-irritation by inunction of soft soap, iodine, mercury, and hot or cold applications, are probably of little use; but actual cautery round about the trochanter is sometimes of value in relieving severe pain.

Ambulatory treatment, by which the patient can move about on crutches, without using the affected leg, should be commenced as soon as the pain and tenderness have disappeared. For this purpose, *Thomas's hip-splint* is very useful. It consists of a rod of iron fitted to the back of the body and thigh, reaching from the shoulder to the ankle, and gripping by means of transverse rings the chest, the thigh, and the ankle, which are thus kept in a rigid line. A patten, two inches or so high, is worn on the sound foot, and the other is allowed to swing free. To prevent the splint from slipping round, a *double Thomas's hip-splint* is effective. Here the other splint reaches only to the thigh, and the sound leg has the use of the knee. The same effect may be got, and in young children sometimes more easily, by encasing the body, pelvis, thigh, and leg in plaster-of-Paris, which may be reinforced with wire or strips of tin or aluminium. Other splints of the same nature made of celluloid, aluminium, etc., are quite as effective, but expensive. Whatever apparatus is employed, it must be worn until all pain and tenderness are gone, and the patient can bear firm thumping on the trochanter or the heel, when it should be left off altogether.

Operative Treatment.—If there is "tubercular suppuration," in most cases the pus should be let out, either by aspiration, with or without subsequent injection of iodoform emulsion, or by incision. In the latter case, the abscess walls may be scraped and flushed out with sterile fluid, and the cavity filled with iodoform emulsion, and then sewed up. At the same time any sequestrum should be scraped out, and all visible tubercle removed. Thus, if any open operation is required, it is better to expose the joint freely at once, and perform arthrectomy, with the least possible damage to the undiseased parts. The head should not be excised unless it be quite destroyed; and care must be taken in curetting the acetabulum not to penetrate into the pelvis. It sometimes happens that the tubercular focus is confined to the neck, where it may be reached by boring through the trochanter, and removing it without opening the joint cavity; but the opportunities for this are rare. If there are many sinuses, pyogenic infection, disease of the kidneys, or signs of increasing toxæmia or exhaustion, it may be necessary to disarticulate the limb at the hip, in order to save life.

If **ankylosis** takes place, the position to be finally attained is that of slight flexion and considerable abduction. This allows of comfort in sitting; and by tilting of the pelvis, and the use of a patten, a great amount of the shortening may be overcome. Ill-fitting apparatus, or untreated disease, may cause too much flexion, or inversion; this may be corrected if necessary by osteotomy through the neck (*Adams*), or below the trochanters; but unless the bad position interferes with the patient's occupation, it is often better not to correct the deformity.

The **knee joint**, from its exposed position, is very liable to diseases as well as injuries. It is the common site of acute and chronic synovitis, both simple and infective, of osteoarthritis, rheumatism, and hydrops articuli.

Tuberculosis also is common. It arises about equally in the synovial membrane and bone (patella, femur, or tibia, or simultaneously in more than one bone). There is often a history of injury, which may be quite slight. The disease is limited by the capsule, and unless suppuration takes place it does not spread into the surrounding tissues. Further, if the patella becomes fixed to the femur at an early stage, the upper part of the synovial sac beneath the quadriceps tendon may be shut off from the rest of the joint, and either division may heal, while the other progresses to destruction.

Symptoms.—There is pain and restriction of movements, followed usually by hydrops, which causes bulging at the sides of the patella, with fluctuation and "floating of the patella" (*i.e.* the patella is raised by the fluid from its normal position in contact with the femur, and can be felt impinging on it only on firm pressure). There is usually more thickening of the capsule than in simple synovitis, loose bodies are frequently felt, and the knee feels warmer than the normal. If the disease progresses, "white swelling" develops; and fluctuation gives way to doughiness, and "floating" disappears. Mobility becomes still more restricted, and in the fungating stage there is fixation, with partial flexion of the leg, and sometimes subluxation.

The disease progresses, as elsewhere, to abscess-formation, unless a cure is effected.

Treatment, as in other joints, is at first by fixation, most conveniently by plaster-of-Paris applied from the hip to the ankle or foot. This permits of ambulatory treatment as soon as the more acute symptoms are relieved by extension. *Thomas's knee-splint,* may be used for the same purpose; it consists of two stout iron rods, fixed at the upper end to opposite sides of an oval ring embracing the thigh, and resting against the ischial tuberosity, and at the other end by a cross-bar below the heel. The splint is fixed to the leg by broad leather bands, and it may be fitted with various forms of foot-pieces on which to walk. A patten is worn on the sound foot to keep the pelvis level, and the patient can move about with a stick, walking on the sound leg and, through the medium of the splint, on the ischial tuberosity of the diseased side. Contracture and bending of the knee should be previously corrected. The knee is a favourable joint for iodoform injection and Bier's congestive treatment.

Operative Treatment.—If the joint has to be opened for the removal of pus, it is generally found to be more extensively diseased than the external appearance would suggest; and arthrectomy of some degree is often required. As this results in fibrous or only partially bony ankylosis, it is, in most cases, as well to perform an excision at once. This is done by removing a slice from the femur and tibia, and so getting complete bony union. Any deep focus in the bones may be scooped out, and the cavity filled with iodoform paste. The patella is generally removed, as it rarely escapes being diseased. The flat ends of the bones may be pegged together with steel nails or staples, to prevent displacement. The incision may be curved downwards or upwards, either of which gives free access to the whole of the joint; but in cases where it is doubtful if a full excision will be necessary, a perpendicular incision may be made at the side of the patella; and if the state of the joint is found to be more serious, this may be extended by curving it round the tubercle of the tibia, which is then chiselled off, along with its attached ligamentum patellæ. In this way the quadriceps muscle retains its attachment as long as it is useful, and the tubercle may be replaced after the excision is completed. In children especially, a slight splint should be worn at the knee, for many months, to prevent later bending of the knee. This may occur either from yielding of the soft bones, or from unequal growth at the epiphysial line.

The **ankle joint** may be affected with pyogenic or gonorrhœal arthritis, Charcot's disease, or with chronic synovitis and neuralgia, the result of injury.

Tuberculosis in the ankle and tarsal joints is common in adults as well as in children. It begins either in the bones, or (1 in 3) in the synovial membrane. The symptoms are pain on pressure of the weight of the body, limping, and loss of the natural spring of the foot. At the ankle, the effusion causes bulging at the sides of the tendo Achillis and to some extent in front of the joint. In the tarsal joints, there is swelling over the dorsum, and the tendons may be displaced or involved in the disease.

Treatment.—Conservative treatment should be adopted at first; but if it is unsuccessful after two months' trial, operative measures are called for, as the disease is apt to spread rapidly. In children, it is often sufficient to curette away all the visibly diseased parts, even if this has to be repeated several times. In adults, however, partial operations rarely give good functional results; and, as it is important that the patient should get the use of his leg as soon as possible, a more complete resection or an amputation is generally necessary.

Metatarsalgia is a boring pain in the foot at the third and fourth metatarso-phalangeal joint. It is supposed to be due to pressure on the interdigital nerves. It is often present in flat-foot; but is sometimes associated with wearing badly-fitting boots.

Treatment.—It disappears with rest, and is often relieved or prevented from returning, by wearing a flat-foot pad on the inner side of the boot. In obstinate cases, the head of the fourth metatarsal bone may be excised.

CHAPTER VII.

DISEASES OF THE SKIN.

Certain diseases of the skin must be considered from a surgical standpoint. When the skin is affected with any disease of an **inflammatory** nature, the microbes in the region of the wound become immensely increased in numbers; and for this reason, operation wounds made in those localities are specially liable to suppuration, at least in the superficial layers, stitch abscesses being a common result. If, therefore, an operation is to be performed on such a diseased skin, it is wise to delay operating when that is possible until the inflammation has been relieved by soothing ointments. If immediate operation is imperative, the skin should be thoroughly scrubbed with hot soap and water, then with turpentine and alcohol, and the part well stained with tincture of iodine, which, though very irritant, is a strong disinfectant. After a minute or so, the excess may be washed off with alcohol. At the end of the operation, the inflamed skin may be painted over with a saturated solution of picric acid, which forms a dry skin over the surface. The dressing used for such a wound must always be an absorbent one, never a "sealed" dressing, and it must be changed frequently.

Tattoo Marks.—It is sometimes desirable to remove tattoo marks, especially those on the face, caused by the entrance of particles of dark sand, gunpowder, and the like, in connection with wounds or scratches. To prevent tattooing, all wounds of the face should be completely cleared of such particles, by scraping with a blunt spoon and gauze, if necessary using an anæsthetic. If the foreign bodies are already embedded in the skin, it is sometimes advisable to encourage superficial suppuration, in the hope that they may be discharged. For this purpose a dressing of soda and soap is applied on a piece of lint, and bound in place for a day or two. There may be considerable cicatrisation, but that is less unsightly than the tattoo. Deep tattoos can only be removed by free cautery or excision.

Boils (*furuncules*) are localised suppurations in the deeper layers of the corium, commencing in a hair follicle; the active cause being staphylococci. They are apt to come out in crops, in people who are predisposed to them by overwork or worry, over- or under-feeding, bad hygiene, or dirty conditions. The most common sites are the back of the neck, where the collar rubs, and the buttock; but they appear also in the auditory meatus, the nose, and the eyelids (*stye*). Doctors are apt to suffer from boils on the hands; and here the chief method of infection is scrubbing the soiled hands with a hard nail-brush, so that the fibres, even if sterilised, pierce the skin with a minute wound and carry in infection from the more superficial parts of the cuticle. The indiscriminate use of strong antiseptics on hands which are not naturally tolerant, greatly increases this liability. The *symptoms* of boils are familiar to all,—small painful spots surrounded by zones of redness and extreme tenderness. The central part "points" in the course of three or four days, as a white spot in the thinned skin.

Treatment.—As they are extremely painful, all constrictions should be removed to give relief. Very small boils may subside and disappear; but usually they go on to the point of bursting. Unfortunately, they occur frequently in places where the skin is very tough, and they should therefore be incised with a sharp bistoury, as soon as they begin to show pointing. After evacuation, they should be dressed with warm moist antiseptic lint, to relieve pain and tension, and to keep the discharge from infecting the surrounding skin and so giving rise to a crop. For this reason, all household poultices should be banned. Yeast, taken internally, either as an emulsion, or preferably in the form of fermenting beer or porter, is said to have an antibacterial effect on staphylococci; in the latter way, at all events, it often has a good "tonic" effect.

A **carbuncle** begins in a similar way to a boil; but it is of a more malignant nature, as it implies a certain amount of sloughing of the skin, and has a much greater tendency to spread. It does not form such a conical swelling; and the skin, instead of pointing at the middle, breaks down in several spots, and the central part sloughs. The surrounding tissues are infiltrated and tender, and the skin is often undermined at its edges. The constitutional effects are sometimes pronounced in the earlier stages until the discharge is relieved. Sometimes the disease is so severe that the patient may die of septicæmia or pyæmia.

Treatment.—Incisions should be made into the central part, and all the dead skin cut away with scissors. The soft, sloughing tissue below it may be scraped with a spoon, and swabbed with pure carbolic acid; but it is safer, and probably just as efficient, simply to irrigate the wound, and pack it thoroughly with iodoform gauze. Over this, however, may be placed a large hot antiseptic dressing to encourage effusion. As the disease spreads, all sloughs must be removed piecemeal. Constitutional treatment in these cases is important, as carbuncles seldom occur except in persons who are "run down."

Onychia is inflammation of the nail bed, and, if neglected, it is apt to spread to the neighbouring pulp of the finger (*paronychia*), and from that to the tendon sheaths (*thecal abscess*). It may arise from septic injuries, or from slight lacerations at the sides of the nails ("torments") becoming infected, and amongst surgeons it is apt to arise in the course of operating on purulent cases. The end of the finger becomes swollen, and the throbbing pain is intense. A pale area can generally be seen beneath the nail, and a drop of pus may be squeezed out. The lymphatics of the forearm are outlined in red, and the elbow and axillary glands are enlarged.

Treatment.—The nail should be twisted off by strong forceps as soon as possible, and the part dressed with antiseptic dressings, warm and moist at first, to relieve tension and pain. Should the disease spread to the tendon sheaths, it must be treated as on page 147 (*v. Teno-synovitis*).

Corns are thickenings of the corium, the outer layers of which become horny, and the inner growing ones (the *core*) consequently compressed, giving rise to pain and extreme tenderness, and usually surrounded by a zone of inflammation. Corns occur chiefly on the outer edges of the toes and feet, and are caused by prolonged intermittent pressure of tight or badly-fitting boots. They occur also as soft corns between the toes. In other parts of the body they are rare.

Treatment.—The corn may be softened by bathing it with warm water and soda, and, after drying, it should be painted with a solution of salicylic acid in collodion. This loosens the superficial layers of the epithelium, and they come off as a flat scab. The process is repeated until the core disappears and the skin seems normal. A quicker way is to pare off slices with a razor until the core is reached, when it may be scooped out. Corns may be easily kept down by rubbing the surface nightly with pumice stone. Soft corns should be treated with salicylic acid, and the surfaces kept from touching by separating them by small pieces of absorbent wool.

Warts (*verrucæ*) are papillomas of the skin. The simple warts (*v. vulgares*) of children are usually multiple, and are seen chiefly on the hands. They are generally branched, but may be flat and sessile. Their origin is obscure, but probably they are due to irritation of some kind. They are apt to disappear quite suddenly; and this fact accounts for the former belief in spells, and the credit now given to many drugs for effecting their cure.

Treatment.—The best method is to touch them daily with glacial acetic acid, applied with a piece of stick.

Keloid is a hypertrophied condition of the skin, which appears in some predisposed people as a result of injury to the skin, especially in those subject in some way to tuberculosis. If it occurs in the line of a wound, it is often spoken of as *false keloid*, but apparently the process is the same as in the idiopathic form. Pathologically, it consists of granulations with an excess of fibrous tissue; it resembles an avascular fibroma.

Treatment.—Excision of the swelling or scar is followed by a recurrence in the same place, and re-excisions only lead to further recurrences. X-rays and high-frequency currents have been tried with success in some cases, but without any good results in others. The least unsatisfactory treatment is time.

Lupus vulgaris is tuberculosis of the skin, slow in growth and refractory to treatment. It starts most commonly on the ala of the nose, and spreads to the point and the adjacent areas of the cheeks; but it may attack the skin at any other point. Pathologically, it consists of small tubercles in the deeper layers of the corium, which, like tubercles in other tissues, are surrounded by a zone of inflammation, and tend to caseate in their central parts. The result of this is to produce ulceration of the surface, which may penetrate deeply and destroy large parts of the nose and cheeks, sometimes spreading to the palate, fauces, etc. In favourable cases, the central parts atrophy without much destruction of the underlying tissues, and cicatrisation takes place. But even in such cases, recrudescences are not uncommon, after an apparently complete cure.

Treatment is described in the section on the face.

SECTION III.

INJURIES AND DISEASES OF SPECIAL REGIONS.

CHAPTER I.

INJURIES AND DISEASES OF THE HEAD.

INJURIES OF THE SCALP.

Contusions of the scalp often result in much extravasation of blood, owing to its great vascularity. When purely subcutaneous, these are usually small and of little importance, as they are rapidly absorbed. Subaponeurotic hæmatoma (*cephalhæmatoma*) may, however, give rise to difficulty in diagnosis, especially if there are cerebral symptoms present. The central part of the hæmatoma is soft, while the outer edge is sometimes so hard from the clotting of the blood, that it feels like the edge of a depressed fracture; but if the finger is kept pressing on it for some time, it soon forms a pit in the hard edge. The so-called *caput succedaneum* of new-born infants is a circumscribed area of œdema, and sometimes of extravasation, produced by prolonged pressure of the uterine walls on the scalp, except where they are not in contact (at the os uteri), and where the swelling consequently appears.

Treatment.—In most cases no operative treatment is necessary. If there is great distension, however, the swelling may be punctured; if bleeding continues, a free incision should be made, and the bleeding point stopped.

Wounds of the scalp usually penetrate to the pericranium; but large parts of the scalp can be torn away by machinery accidents, without injury to that membrane. Blows on the head made with a blunt instrument often produce linear wounds like those made with a knife. From the circumstances of their occurrence, many scalp wounds are lacerated and become contaminated with gross dirt, and are liable to sepsis; but if they can be kept aseptic, they heal readily, in spite of extensive bruising and tearing, owing to the very free blood-supply.

Treatment.—The skin round the wound, and in large wounds the whole scalp, should be shaved, the fatty secretion removed with turpentine or ether, and the surface washed with alcohol. The wound itself should be cleaned with tufts of gauze, and rinsed out with saline solution. All hæmorrhage must be accurately stopped: but it is difficult to apply artery forceps to the vessels in the edges of the scalp, as they retract into the dense tissue, and it is sometimes necessary to pass a suture with a needle, penetrating the scalp and including the vessel in the stitch. Clean incised wounds in which little secretion is expected should be sutured. Lacerated and especially dirty wounds should be packed with strips of iodoform gauze, and the dressing changed before it becomes saturated with discharge. The edges of the scalp wound should be approximated by a few sutures, to prevent undue retraction.

DISEASES OF THE SCALP.

The scalp is liable to various **skin** diseases, which need not be discussed here. *Erysipelas* and **cellulitis** in the scalp, however, are more dangerous than elsewhere, on account of the free communication of the superficial vessels with the brain and its membranes, and the possibility of infection passing directly inwards.

Tumours of the scalp are rare, with the exception of simple and cavernous **angiomata**, which are fairly common in this region. These should be excised for preference, and their removal may be carried out with but little hæmorrhage if a rubber band is fastened round the head as a tourniquet.

Sebaceous cysts (*wens*) occur most frequently in the scalp. They are either single or multiple, and are caused by retention of sebaceous matter in the ducts and hair follicles. They produce rounded, flattened protuberances, varying in size from that of a pea to that of an orange, or larger. The skin over them becomes thinned, bluish, and denuded of hair. Owing to the tension in the dense scalp, the smaller ones are hard, but they become softer as they increase in size.

Treatment.—After disinfecting the skin about the swelling, a knife should be plunged into its base and made to cut outwards, dividing it into two parts, which are then held apart. The capsule of the cyst on each side is seized at the base with a forceps and pulled out, or, if adherent, dissected away. The wound should not be sealed, as infective secretion is apt to be pent up, but closed with one or two sutures after bleeding is stopped, drained, and a light absorbent dressing applied. This method is as efficient as the more tedious one of dissecting out the cyst from above, without opening it purposely, especially as the sac so often bursts during the process.

INJURIES OF THE SKULL.

Injuries of the head may occur before or during birth, and may cause temporary or permanent **deformities** of the skull. These are generally confined to *overriding* of the parietal bones, or *depressions* in the parietal or frontal bones. The former generally disappear naturally, and only in rare instances are the venous sinuses torn. The latter are apt to be overlooked until after some days, when the swelling has subsided.

Treatment.—In ordinary cases the skull may be gently kneaded with the hands with the object of restoring the normal shape. As a rule, there is no functional disturbance from the deformities, and only in cases where there is paralysis or other result is any operative measure called for. Should signs of pressure arise, the depression can often be removed by inserting a bone elevator beneath it through a small opening and levering it up; while in well-ossified skulls, a trephine opening may have to be made. Well-marked circular depressions may be treated by applying a large trephine, removing the disk, and replacing it upside down (*Nicoll*).

Contusions of the skull may cause subcranial hæmorrhage, and sometimes give rise to inflammatory thickening or to a focus of suppuration. The latter is due doubtless to infection through some unrecognised channel.

Wounds of the skull may be included amongst contusions or fractures, according to their nature. *Non-penetrating* wounds are not of any special importance apart from the dangers inherent in wounds of bone along with the soft parts. Small *punctured* or *incised* wounds of the skull present a narrow pit or a furrow on the outer table, while the inner table is bulged inwards and forms a rounded mound or ridge, the middle part of which may be splintered. In this way, pressure may be exerted on the cranial contents, or spicules of bone may be broken off and penetrate the brain. Large punctures and gunshot wounds have the character of depressed or comminuted fractures, and are treated as such.

Treatment.—If there is obvious depression, a circular piece of bone may be removed by a trephine. Any weapon or foreign body should be removed if accessible; but it is highly inadvisable to probe for bullets or other missiles lying deep in the skull. In many cases their presence does no harm: and if they cause any irritation, they should be carefully located by means of X-rays before attempting to operate for their removal. In small punctured wounds it is often unnecessary to do more than heal the external wound. (See also *Compound Fractures.*)

Fractures of the skull are caused by direct violence, *e.g.* a blow or a fall, affecting the vault; or by indirect violence, *e.g.* a jar from falling on the feet, or a blow on the lower jaw: fracture of the base often arises in the latter way. They are divided into *fissured*, *comminuted*, *depressed*, *gutter-* or *pond-shaped* fractures, which are met with in the vault. Fractures of the base are usually fissured; in the latter variety, the bone is simply cleft without displacement, and presents no particular signs. In comminuted fractures some of the fragments are generally depressed, and may be slid under the other bones, or may penetrate into the brain tissue. In gutter- and pond-fractures—a further stage of punctured wounds of the skull—the inner table may be splintered, so that a fragment larger in size than the external depression is separated and projects inwards. This is due rather to the lines of stress in bending the skull inwards with a blow, than to any special property of the more brittle inner table, as was formerly believed. Fractures of the base are usually continuations of fissures in the vault, and travel round the skull along the tracks of least resistance, between the bony buttresses of the face, the ear, and the occiput. They may be produced also by *contre-coup*, *i.e.* force transmitted to the opposite side of the head, by travelling round the skull in various lines and meeting at a point. The fissures may run in any direction, but usually confine themselves to one fossa. Those involving the frontal sinus, the cribriform plate, and the middle ear are usually compound, and are liable to all the dangers of compound fractures. Gunshot fractures are often produced by the *bursting* stress of the sudden impact of the bullet on the rigid cranial cavity filled with the semi-fluid substance, the brain. The effect is to produce such an injury as might happen from the use of an explosive bullet.

Symptoms.—Fissured fractures are not easily detected, and are probably often overlooked. When exposed in the depths of a wound, the lines of fracture are distinguished from the sutures by their red colour due to hæmorrhage, and sometimes by the presence of hairs nipped between the edges. In the absence of a wound or depression, it is not necessary to determine their presence by incision, as the treatment is that of concussion or other complication that may accompany the injury. Punctures or small depressions are nearly always compound, and need not be suspected unless a wound or large sulcus is present. Depressed fractures of some size are diagnosed by feeling the projecting ridge of the upper bones (*cf. Cephal-hæmatoma*); but no undue pressure should be used, lest the movable fragment be driven inwards: when compound, they are obvious. Fractures of the base are difficult to detect, except by the resulting effusion of blood, cerebro-spinal fluid, or brain matter, or by interference with nervous functions. Fracture through the *anterior fossa* generally leads to hæmorrhage, with ecchymosis under the conjunctiva appearing after 24-36 hours or so, and spreading from behind forwards, often accompanied by exophthalmos. This should not be confused with ecchymosis of a black-eye, which appears at once, and is distributed all over the front of the eye. In other cases there may be hæmorrhage or discharge of cerebro-spinal fluid from the nose, through the ethmoidal plate, or extravasation at the back of the pharynx. In some rare cases particles of brain-matter have been discharged from the nose. In the *middle fossa* the petrous bone is usually involved, and the tympanum is often fissured. This generally causes rupture of the tympanic membrane, and blood, followed by cerebro-spinal fluid, discharges through the roof of the cavity and out of the meatus. This may be distinguished from the mucous discharge of a chronic inflammation of the middle ear, by the great quantity of the fluid, the comparative absence of albumen, and the excess of chlorides in it. When the membrane is not ruptured, the discharge may take place through the Eustachian tube. In fractures through the petrous bone, the facial nerve also may be injured, with spasm or paralysis following it; or, less commonly, the acoustic nerve may be injured, and deafness may result. But as deafness is apt to occur from other causes after an injury, it is an unreliable symptom of fracture. Other nerves at the base of the skull are less liable to injury. Hæmorrhage into the cranial cavity is very common in basal fractures, and indeed also in fractures of the vault, and gives rise to symptoms of *compression.*

Prognosis.—Fractures of the skull are not themselves specially dangerous, but become so from the frequent occurrence of injury to the brain, and of hæmorrhage and sepsis. Some concussion nearly always accompanies fractures of the skull. Repair takes place as in other bones by callus-formation; but, owing to the absence of movement and irritation, it is slow in appearing and slight in amount. Only the permanent callus is formed; the provisional callus usually seen in other bones not making its appearance.

Treatment.—Simple subcutaneous fissures without any special symptoms are treated by rest in bed, relaxation of the bowels, and light diet for a week or so. The patient should not be allowed to resume his work for a month or six weeks, and should be kept under observation for six months; and all excitement and abuse of alcohol avoided for some time afterwards. If any signs of irritation of the brain arise, the head should be shaved, and cooled with ice bags or Leiter's tubes. Small depressions and punctures often give rise to no disturbance of function, but as there is always a danger of subsequent irritation from spicules of bone in the cortex, it is safer to remove a disk of bone enclosing the depression, even if there be no wound of the scalp. Large depressions should be exposed and the depressed part levered up with a strong elevator, after removal if necessary of some of the adjacent bone by rongeur-forceps or trephine. In fractures of the base, infection may spread from the nose, but it is impossible to disinfect the nasal cavities; packing with iodoform gauze may be employed if there is severe bleeding, but otherwise it tends only to increase the mucous secretion, and antiseptic lotions have the same effect. Where there is discharge of cerebro-spinal fluid from the ear, the meatus should be thoroughly wiped out, any wax, etc., being removed with aural forceps; and it is packed lightly with iodoform gauze, which is changed as often as it becomes saturated. The auricle and the skin around are made surgically clean, and a dry absorbent dressing may be put over all. This is safer than trusting to irrigation with antiseptics, which might drive infective matter into the middle ear and skull. Compound fractures must be cleansed thoroughly, and may be flushed with sterile saline solution, but antiseptics should not be brought into contact with the brain tissue. All foreign bodies, dirt, or splinters of bone must be removed, and depressed pieces of the skull elevated; isolated pieces separated from the soft parts usually die, and they should be removed, unless there is no reasonable doubt that the wound is aseptic. The edges of the hole should be trimmed with rongeur-forceps, and the surface covered over wherever it is possible; if necessary, a flap of scalp may be taken from the adjoining part to do so, while the part left bare is allowed to heal by granulation and grafting. The wound and all pockets, however, must be freely drained by tubes, or better by gauze packing frequently renewed. Bone grafts may be used afterwards to cover defects of the skull, the *König-Müller* process being employed if possible, in which an osteoplastic flap formed of the scalp and outer table only of the skull is slid over the defect.

Sequels.—(1) *Compression* from hæmorrhage is common, especially if any of the larger vessels are torn. (2) Traumatic *glycosuria* or *polyuria* is often noticed as occurring after two or three days, and lasting for a week or so. It varies with the amount of irritation to the medullary centres, but is of no special importance for prognosis or treatment. (3) Sensory or motor *paralysis* or *irritation* may result from injury to nerves, especially those of special senses. Impairment of vision or movements of the eye and loss of smell are comparatively rare. Tinnitus, deafness, or vertigo sometimes occur, but may arise from direct injury to the cochlea or semi-circular canals. Neuralgia and headache may arise from involvement of the fifth nerve, or of the nerves of the dura mater. (4) *Jacksonian epilepsy* may ensue from penetration of foreign bodies or spicules of bone into the cerebral cortex, or from sclerosis resulting from the concussion injury. (5) Derangement of the *intellectual* faculties depends on the amount of concussion or laceration. (6) *Hernia cerebri*, or protrusion of brain tissue through a defect in the skull, only occurs when the internal tension is abnormal, and this is practically always due to infective inflammatory œdema. In such a case treatment is confined to relieving tension and dealing with the sepsis. (7) *Traumatic cephal-hydrocele*, or *spurious meningocele*, sometimes occurs in children suffering from fractures of the vault. It consists of a sac distended with cerebro-spinal fluid protruding through a rent in the skull, which remains patent. There are reasons for considering that it is due to conditions similar to hydrocephalus, as no treatment short of that for congenital cephalocele seems to cure it.

DISEASES OF THE SKULL.

Atrophy of the skull, with a special liability to fracture, sometimes occurs in the aged. And ostitis deformans and osteomata, occasionally in the form of leontiasis ossium, in middle-aged people give rise to local or uniformly diffused **thickening**, with or without causing pressure symptoms on the brain.

In **rickets** affecting children there is softening in patches (*cranio-tabes*), and the eminences become thickened and more prominent, giving rise to the square or "hot cross-bun" shaped head. This may simulate the deformities of chronic hydrocephalus or syphilis, and must be distinguished from them chiefly by the softness of the bones, and other signs of rickets. The anterior fontanelles also are late in closing, and, instead of doing so at the fifteenth month at the latest as in normal conditions, may remain open up till the third year.

Acute Osteomyelitis is a dangerous disease which may arise from wounds. When it follows a simple hæmatoma, as it sometimes does, it is generally due to infection through a minute abrasion on the skin. The characteristic sign is a rounded swelling of inflammation and œdema on the scalp, known as **Pott's puffy tumour**. This is accompanied by great tenderness and severe headache localised at the point of swelling. The appearance of such a tumefaction over the skull, or indeed over any bone, should always lead the surgeon to suspect osteomyelitis beneath it. The disease is apt to implicate the dura mater, and set up pachymeningitis. In the mastoid region, acute inflammation sometimes leads to meningitis, and chronic inflammation to abscess in the brain or cerebellum, or to infective thrombosis of the sinuses.

Treatment.—The bone must be exposed, and the diseased part removed with a trephine, lest the infection may have spread to the inner surface.

In acquired **syphilis**, the skull is liable to tertiary thickenings, spoken of generally as periostitis, but often of true gummatous nature; and to gummata proper which form nodes. Both of these have a tendency to extensive ulceration, and great areas of the skull may be destroyed, and the whole thickness may be penetrated. Reparatory inflammation may cause encroachment on the cranial cavity.

In hereditary syphilis there is often found in children a form of cranio-tabes, with thinness and brittleness, along with local thickenings especially on the parietal bones (Parrot's nodes).

Tuberculosis may affect the diploë of the cranial bones, but it is not common. It is similar to tuberculosis in bones elsewhere.

Sarcomata of various kinds, but more commonly osteosarcomas, may arise as primary tumours in the adult. They should be removed as soon as they are diagnosed.

INJURIES OF THE BRAIN.

General considerations on brain injuries.

All injuries to the head are important from the possibility of the brain being involved, either from the immediate violence or from pressure of effused blood or œdema, or from subsequent inflammations.

Localisation.—**A.** Certain parts of the **brain** are recognised to be the seat of control over certain functions, notably movements and sensations; whilst the relations of other parts and functions are still problematical. Of the accepted localisations, the chief are the *sensori-motor* areas, and are as follows:—

(1) **The Rolandic area**, *i.e.* the convolutions adjacent to the fissure of Rolando, consisting of the ascending frontal, ascending parietal, the paracentral convolutions and the inferior fronto-parietal (*Broca's*) convolution, and the island of Reil. It is associated with the functions of the body and limbs. Those of the face, mastication, tongue, and larynx are situated

at the lower part on both sides of the fissure; those of trunk and lower limb at the upper end and the paracentral lobe; those of the upper limb between these limits.

(2) The **pre-Rolandic area**, at the upper (posterior) end of the frontal convolutions, is associated with speech and writing, the former at the lower part near the centre for the tongue and larynx, the latter rather higher near the centre for the upper limb.

Sensory centres.

(3) The **temporo-sphenoidal** lobe, in whose upper two convolutions is situated the hearing centre; and near it, posteriorly, the auditory centre for words, destruction of which causes *word-deafness.*

(4) The **occipital** lobe, which is the seat of visual impressions; and near it, in the angular gyrus, the visual centre for words and symbols, destruction of which causes *word-blindness.*

(5) The **internal surface** of the temporo-sphenoidal and calloso-marginal convolutions are probably the seats of taste and smell.

(6) The **frontal** convolutions are generally considered to be associated with intellectual processes.

The **cerebellum** is associated with co-ordination of movements; and injuries may give rise to ataxy or dizziness.

The **medulla** contains the centres for respiration and circulation; but also the nuclei of the glossopharyngeal, vagus, spinal accessory, and hypoglossal nerves. Injuries which do not prove fatal by implicating the vital centres, therefore, may affect these nerves.

These localisations are fairly constant, but there is considerable overlapping of the adjacent centres.

B. In order to *find these areas on the* **skull** for operative purposes, a number of methods have been devised, the most reliable of which are here given.

Reid's base line is the fundamental part of many of the measurements. It is a line drawn horizontally round the head, passing through the lower margin of the orbit and the middle of external auditory meatus. It is practically parallel with the zygoma.

The **Rolandic point**, indicating the upper end of the fissure of Rolando, is $\frac{1}{2}$ an inch behind the mid-point of a line drawn over the vertex from the glabella to the inion (external occipital protuberance). It may be found also by drawing a line perpendicular to Reid's line from the most posterior point of the mastoid process, and marking the place where it meets the middle line of the skull. From this point the **fissure of Rolando** extends downwards and forwards for 3½ inches at an angle of 67°. This may be readily measured, in the absence of a protractor, by *Chiene's* method of folding a square sheet of paper diagonally, to get an angle of 45°, and folding this again in two, to get the angle of 22½°, from which the angle of 67½° is at once available. The *line* of the Rolandic fissure may be found also by joining the Rolandic point to another point, found by the intersection of two lines, one parallel to Reid's line but at the level of the external angular process of the frontal bone (the so-called *superior line*), and the other perpendicular to Reid's line drawn at the front edge of the tragus.

The **fissure of Sylvius** starts at a point 1¼ inches behind the external angular process, and ¼ inch above its level. The anterior limb of the fissure ascends perpendicularly for 1 inch, while the posterior or horizontal limb extends backwards to a point ¾ inch below the parietal eminence.

The line of the **lateral sinus** (lower margin of the cerebrum and the upper margin of the cerebellum) coincides more or less with a line drawn ½ an inch above the inion to ½ an inch above the auditory meatus. It turns suddenly downwards ½ to ¼ of an inch behind the meatus, and it varies in breadth from ⅓ to ½ an inch.

The **middle meningeal artery** may be found by drawing a series of lines perpendicular to Reid's line at intervals of ½ an inch, beginning 1 inch behind the external angular process, and extending upwards for 1, 1½, 2, 2½ inches respectively above the zygoma; the artery lies along the upper ends of these lines (Treves's surgery). The most common seat of injury is in the canal in the anterior inferior angle of the parietal bone, and here it may be found roughly one finger-breadth behind the external angular process and two finger-breadths above the zygoma.

Operations on the brain. Of late years numerous devices have been introduced for opening the skull to gain access to the brain. The trephine, however, holds the first place for ordinary purposes; the most useful sizes being 1 and 1½ inches in breadth. The locality is marked out on the scalp by one of the methods mentioned above; and a mark is made in the bone by driving the centre-point of a trephine through the scalp into the outer table, so that a small pit remains visible when the skin flap is raised. If the trephine opening is found to be too small, it may be enlarged by rongeur- or gouge-forceps; or two openings may be made, and the bridge between them divided by a saw. For this purpose *Gigli's* wire saw, introduced under the bone with a special director and guard, is the most satisfactory. When a large part of the brain has to be exposed, *Wagner's* temporary osteoplastic resection should be employed.—A horse-shoe flap, corresponding to one of the main vascular areas, is cut on the scalp, with its base downwards so as to leave a sufficient blood supply for it, by avoiding the larger vessels. The bone is cut through approximately along this line of incision by a chisel, spiral osteotome, or circular or Hey's saw; but the simplest way is by Gigli's saw introduced through a series of small openings $\frac{1}{4}$ of an inch in diameter made with a trephine or burr. The base is not sawn through, but cracked across by levering up the bone flap. When the skull is opened, the dura mater is incised around the opening $\frac{1}{4}$ of an inch from the edge, to form a flap. At the conclusion of the operation this is replaced and sutured into position; and the bone flap easily falls into its place. If a trephine opening is small, the defect is filled up with firm and tough connective tissue, which effectually prevents any protrusion of the cranial contents; but if a large area is removed, the connective-tissue covering is apt to yield, therefore the defects should be closed with bone wherever it is possible. Large pieces removed by the trephine should be kept in warm saline solution and replaced after the dura mater is in position. In this respect Wagner's method has a great advantage over all others; in addition, it allows of much greater freedom in exposing the brain, and thus counteracts many deficiencies in localising the parts affected.

Concussion of the brain is the condition of transient depression of all the brain functions, especially consciousness, occurring after a severe head injury, and the immediate passage of this state into death or rapid and complete recovery (Bergmann). It arises from a general commotion of the brain cells, especially those of the cortex, leading to a temporary paralysis: and there is probably first a stimulation, then paralysis of the vasomotor and respiratory centres.

Minute hæmorrhages and even lacerations of the brain tissue have been seen after death from concussion, but quite as many cases occur without any such signs.

Symptoms.—There is sudden loss of consciousness, and the patient lies motionless. The unconsciousness may last for only a minute or two, or for several days; and varies in degree from absolute coma to stupor from which the patient can be roused by shouting or pinching. The skin is pale and cold, and the general temperature is subnormal. The pulse is weak, and at first slow; but soon becomes rapid, and is generally regular in rhythm. Respiration is shallow and slow, and may be interrupted by deep sighs; sometimes it is irregular, but there is no stertor or blowing out of the cheeks. The muscles are flabby and completely powerless; but they recover at once when consciousness is restored. The superficial reflexes—knee-jerks, etc.—are abolished; but the deep ones persist,—the pupils, which are equal and slightly dilated, react to light, and the gullet swallows liquids introduced into the back of the pharynx. The sphincters of the bladder and anus are relaxed, but the bladder and rectal muscles are contractile, and the patient may pass urine and fæces unconsciously in bed. Should the symptoms continue for several days, there is a probability that some other element is present besides concussion; but death may take place from concussion alone if it is severe enough.

As the patient recovers, symptoms of **reaction** appear. There is nearly always vomiting as consciousness returns, and this may be repeated several times. There is usually headache. The pulse becomes stronger and slower, respiration fuller, and the temperature rises, the normal point is reached and passed; but after a time, varying with the intensity of the initial symptoms, these functions again become normal. Should reaction be too great from any cause, œdema of the brain may ensue with signs of compression. If there has been any laceration, the patient often shows signs of "*irritation of the brain.*" Convalescence usually takes place in a few days in the absence of laceration or compression.

Treatment.—The patient is put to bed between hot blankets, with hot bottles to the feet and sides of the body and legs. When consciousness returns, he may be stimulated with tea, coffee, or soup; but alcohol should be withheld entirely, except where there is very severe cardiac depression, as it is apt to cause hyperaemia of the brain and progressive œdema. The bowels should be cleared out as soon as possible after reaction comes on, and for this purpose calomel or croton oil is most convenient. The diet should be light and unstimulating. If reaction is excessive, an ice-bag may be applied to the head.

Sequels.—Complete recovery is the rule, but if there is any laceration or other permanent injury to the brain, and even sometimes without it, a train of nervous symptoms may come on, with loss of memory, inability to concentrate the attention on any work, weariness and pains in the back, sleeplessness, and other "neurotic" conditions. (*See also* Concussion of the Spine).

Compression is the result of excessive tension in the skull. It is due to increase of the fluids in the skull, or to diminution of the skull capacity by foreign bodies, or pathological conditions.

(1) The cerebro-spinal *fluid* varies greatly in amount according to intracranial pressure. If that is high, the fluid in normal conditions escapes into the spinal theca, and is also rapidly absorbed by the capillaries. If there is any obstruction to its exit by tumours, or even by pressure of the brain and medulla against the foramen magnum, or if absorption is interfered with, as happens readily in the event of inflammation with effusion on the membranes of the brain and cord, then the cerebro-spinal fluid remains in excess. The presence of exudation or œdema also adds to the tension. Further, if effusion in the skull proceeds at an excessive rate, escape and absorption are unable to keep pace with it, and compression occurs.

(2) The *capacity* of the skull is diminished most frequently by depressed fractures or foreign bodies, and notably by formation of blood-clot. The latter arises generally from fractures, or at least severe contusions, to the vault, and originates in the meningeal arteries, or less commonly the venous sinuses; or it may occur from rupture of a small aneurism in the cerebral arteries (apoplexy). The fluid blood acts only by increasing the intracranial tension, while clot acts also locally as a foreign body. Less commonly the compressing agents are abscesses and tumours. The intracranial cavity may also be diminished by osteo-sclerotic thickening of the skull, by granulation on the dura mater resulting from previous necrosis, or, in young children, by distortion of the yielding bones.

(3) The *local effects of pressure* on the brain are to compress the capillaries and cause a profound anæmia of the part. This of course abolishes function, and in the cortex leads to paralysis. Even in temporary compression there is often some degenerative destruction of the cells; and permanent impairment of function may persist. In addition, this compression is apt to set up a **progressive œdema of the brain.** This œdema is probably produced by the exudation of serum from the arterioles and capillaries immediately outside the zone of anæmia, where the veins and lymphatics are still compressed. The exudation increases the area of high pressure and therefore of anæmia, and causes the zone of exudation to be still further enlarged. In this way the œdema may spread to an indefinite extent. Such a condition may arise quite suddenly in the vicinity of tumours or other compressing agents which have existed for a long time in a quiescent state; here the balance of formation and absorption of the cerebro-spinal fluid have been maintained until some disorder of the circulation has interfered with it, and pressure effects begin to be felt. The same may arise after injuries which have not shown any immediate grave effects; and it may be encouraged in these cases by anything which might cause increase in the blood-supply, especially the use of alcohol. Progressive œdema following injury to the skull is apt to be ascribed to encephalitis.

The **symptoms** of compression are those of diminished and retarded flow of oxygenated blood through the brain. The higher centres, especially the intellectual and sensori-motor ones, are early implicated and rapidly exhausted. There is restlessness, headache, moaning, and drowsiness; and convulsions, clonic contraction, or rigidity of the limbs, followed soon after by paralysis. This preliminary rigidity of one side should not be confounded with paralysis in the flaccid muscles of the opposite side. There is usually nausea and vomiting; and unconsciousness gradually ensues. The vagus and vasomotor centres are at first stimulated, and produce the characteristic slow, full, and hard pulse; while the respiratory centre reacts by producing slow but regular breathing, along with stertor and puffing out of the cheeks. As pressure increases, these centres become paralysed, and the pulse becomes rapid and weak, and the respirations take on the Cheyne-Stokes character, until death ensues. The heart continues to beat for some time after respiration ceases, hence death is virtually due to asphyxiation. Meanwhile, the pupils in slight compression show contraction on the affected side; which soon changes to dilatation, without response to light, as pressure increases. The pupil on the opposite side follows the same changes, but at a longer interval, and to a less degree. The fundus of the eye on the same side shows characteristic choked disk (optic neuritis), and this may be seen in both eyes in further stages of compression. The body temperature is nearly always raised, and may continue to rise after death. The bladder muscles become relaxed, and allow the urine to accumulate in spite of relaxation of the sphincter till it is full, when the surplus dribbles away. The rectum also is paralysed, and fæces accumulate, or are passed involuntarily.

Prognosis.—The course depends on the cause; if due to depressed fracture the conditions do not progress much unless œdema comes on; if due to hæmorrhage, the bleeding may cease and the symptoms abate, though rapid hæmorrhage from a large vessel is generally fatal; if due to abscess formation or to a rapidly growing tumour, the disease is progressive and certainly fatal unless relief is given. Long-continued pressure as well as very high pressure is also dangerous, from the tendency for œdema to develop.

Treatment.—The pressure must be relieved by elevation of depressed fractures, or by removal of clots, abscesses, or tumours, provided the operation is not more severe than the condition to be relieved. In the case of disturbance of the regulation of the cerebro-spinal fluid, relief may be given by puncture of the arachnoid in the lumbar region (*Quinke*), or by tapping the lateral ventricles through a small burr-opening in the parietal bone. The immediate results of tapping are often remarkable, but the improvement is seldom maintained, and attempts at continuous drainage are generally fatal.

Contusions or **lacerations of the brain** occur from severe concussion, from wounds and depressed fractures, or from internal hæmorrhages. They may take the form of pin-point hæmorrhages, or of large areas of destruction, often containing a central blood-clot surrounded by a zone of œdema like currant jelly in appearance; and the symptoms vary in accord. In all cases following injury, the initial symptoms are obscured by the concussion; but, as this passes off, manifestations of local injury to the sensori-motor areas may appear.

Besides these, there is another condition, spoken of as **irritation of the brain,** which is considered to be due to slight but widespread lacerations, especially of the frontal lobes. Local effects may be absent, but there is a very irritable mental condition. The patient lies curled up in bed, with the head buried in the bed-clothes to avoid light and sound. He remains drowsy, but can be roused, and can sometimes answer questions apparently with intelligence. His temper, however, is short, and he may be abusive or violent on being disturbed. The reflexes are exaggerated. The pupils are contracted and react to light, the pulse is slow and weak, the temperature is normal or subnormal. The urine and fæces are usually passed in bed. Food is generally taken when offered, and when hunger makes itself felt the patient may take it if left at his bedside. This state may continue for some days or for several weeks, and the patient may make a complete recovery ; but generally he loses all recollection of what has happened during the condition. In some cases, not always the most alarming at first, permanent results are left—weakness of the mental faculties and various "nervous" conditions ; though in such instances there is often a hereditary or other predisposition to nervous diseases. In cases where epilepsy follows brain injuries, this nervous tendency can often be traced.

If large areas are lacerated in the sensori-motor region, there will be either irritation causing spasms or rigidity, or destruction causing paralysis. Injuries on one side of the brain cause the opposite side of the body to be affected. Motor aphasia arises from injuries on the left side of the head, except in left-handed people, where the reverse is generally the rule. The effects of lesions on other parts of the cortex are noted on page 246. Lesions produced by a blow are not usually confined to one area, as the hydrodynamic action on the semi-fluid contents of the skull distributes the impact. The cerebellum and medulla generally escape injury, the cerebrum being the chief sufferer.

Repair of brain lesions takes place chiefly by scar tissue, the nerve cells taking little part in the process. Nevertheless, the existing nerve cells have apparently the faculty of taking up new duties by a process of education, and a certain amount of lost function may be thus restored ; but in any case recovery is slow. The scar tissue, too, sometimes produces a region of sclerosis, even after comparatively little destruction of brain tissue.

Results.—There is a descending degeneration in the tracts of the cord corresponding to the areas destroyed in the brain. Apart from the reparatory changes, there is sometimes a "yellow softening" of the nervous elements, which spreads beyond the limits of the original lesion; and this may give rise to a cystic condition. It is thought that it is due to secondary changes in the blood-vessels, set up by the circulatory disturbances near the seat of the contusion; and it is probable that these conditions are the cause also of "traumatic late apoplexies" (*Bollinger*), coming on at an interval of several days or weeks after such an injury. The lesion may be the starting-point of infective meningitis or encephalitis, or of progressive œdema; or it may be followed after an interval of months or years by traumatic (*Jacksonian*) epilepsy.

Diagnosis is made from the signs of local injury, along with concussion, and in many cases by the cerebral irritation which accompanies these injuries.

Prognosis in slight cases due to concussion is good, full recovery frequently taking place. If there is reason to suspect destruction of much brain tissue, the danger to life, even in the absence of infection, is considerable from spreading œdema, and a certain amount of loss of function is inevitable.

Treatment is that of the special conditions present, and, in general, that of concussion.

Rupture of the intracranial vessels from injury is most commonly met with in the middle meningeal artery; less frequently in the sinuses of the dura mater, and the vessels of the pia mater; and comparatively rarely in the intracranial portion of the carotid. The meningeal artery may be ruptured in a fracture of the vault, as it lies in a groove or sometimes a tunnel in the parietal bone, where it is easily torn against a sharp edge, or perforated by a splinter: even slight blows without external signs have ruptured the vessel. Sometimes the meningeal artery of the opposite side is injured by "contre-coup." More violent injuries are required to rupture the other vessels of the skull. In the case of the larger vessels, the blood issues with considerable force and rapidity, and the first effects are due to shock from loss of blood. The later signs are those of compression, and of local pressure or laceration. The blood is poured out either between the dura and pia mater (*intradural* or *subdural*), and forms a diffuse flattened hæmatoma spreading over a great part of the brain, and especially gravitating to the base: or between the dura mater and the skull (*extradural* or *supradural*), when it forms a rounded circumscribed hæmatoma displacing the brain tissue before it as it increases. Its locality is determined more or less by the branch injured; thus the middle part, which is the most common seat of rupture, forms a tempero-parietal hæmatoma; the posterior branch, a parieto-occipital hæmatoma; and the anterior branch, less commonly affected, a parieto-frontal hæmatoma. As a rule, however, the blood is not entirely confined by the dura mater, but escapes by a rent. The fluid is evidently quickly absorbed, and a firm dark clot is left. Effusion of blood in close proximity to brain tissue usually causes some laceration.

Symptoms.—After the injury there is generally a "free interval," in which the patient recovers to some extent from the concussion, and may even appear to be well. If there has been no concussion he may even have gone about his work for a time, and severe bodily or mental excitement have caused recurrence of the bleeding. If shock is a prominent sign, it generally diminishes with cessation of bleeding, on account of circulatory weakness and formation of thrombus in the vessel, or of excess of intracranial pressure. This recovery may set up bleeding again, and the same series of symptoms are repeated. As effusion increases, symptoms of compression begin, with unconsciousness, slowing of the pulse, and stertor. The most common local signs are paralysis of the head and upper limbs, and, in left-sided injuries, aphasia. Owing to the small size of the branches of the middle meningeal artery, hæmorrhage is not so severe over the upper Rolandic area, hence the trunk and leg muscles are less severely implicated. Impairments of sensation are not as a rule easily determined, on account of the mental condition of the patient, but they are useful when positively noted. The general course is that of progressive compression of the brain.

Diagnosis.—The chief points are the evidences of injury, the free interval, and the progressive incidence of the pressure signs.

Prognosis.—The mortality in untreated cases is very high (90 per cent); cases of extradural hæmorrhage treated by operation are more favourable, but intradural hæmorrhages are not very hopeful even after treatment.

Treatment consists of arrest of hæmorrhage and relief of pressure, provided the operation is not likely to be immediately fatal. According to Krönlein, the proper treatment is to attack the middle meningeal artery in either of the places where it is fairly large and where it is most commonly injured, *i.e.* first at the anterior inferior part of the parietal bone; and preferably through a large osteoplastic opening; or, if the hæmorrhage is not there, in the posterior seat of election in the parieto-occipital region. Bleeding must be stopped by ligation of the vessel wherever it is accessible, using a suture if necessary, or by pressure of tampons. The extravasated blood, usually in clots, must be removed with pieces of gauze or with a spoon. The wound is treated as in other cranial injuries.

When the clot is removed, the brain as a rule expands at once and fills up the cavity; but, after continuous pressure for some time, it may take some days to do so. The relief of pressure is generally striking; consciousness returns, the pulse and respiration become normal, and, in the absence of laceration, the limbs regain their powers.

Rupture of the vessels of the pia mater is similar to meningeal hæmorrhage, and treated in the same way. Injuries of the sinuses of the dura mater give rise to similar signs, and hæmorrhage may be stopped by tampons of gauze. Rupture of the carotid in the brain is usually the result of a punctured or gunshot wound. The effect is generally rapidly fatal; but, if recovery takes place, an arterio-venous aneurysm may be formed, causing pulsating exophthalmos.

DISEASES OF THE BRAIN.

Meningitis—Brain Abscess—Sinus Thrombosis.

Inflammation of the meninges and brain arise (1) from penetrating wounds and compound fractures, by direct infection; (2) from subcutaneous contusions and fractures which have become purulent; (3) from inflammation of the middle ear and mastoid cells, by spread of infective material (*a*) through direct openings, due to necrosis or to the non-closure of sutures in infants, (*b*) through numerous emissary veins penetrating the bone, and (*c*) along nerve sheaths and canals; (4) from extension of inflammatory diseases like erysipelas of the face and scalp, through the communicating branches between the facial and superficial veins of the scalp on the one hand, and the cavernous and longitudinal sinuses on the other.

The results, according to Macewen, are as follows:—

(1) If the inflammatory process be slow and mild, and distinctly localised, then an external *pachymeningitis* (inflammation of the dura mater) may form, possibly with pus between the dura mater and the bone, producing an *external dural abscess.*

(2) Should this condition persist, *adhesive inflammation* is apt to spread to the inner side of the dura, and this may result in a soldering of the inner membranes. In this way leptomeningitis (inflammation of the arachnoid and pia mater) is guarded against, in the same way as a general pleurisy is prevented by inflammatory adhesions from following abscess of the lung. Once the adhesion has become firm, it may act as a barrier to the ingress of fresh infective matter.

(3) Should an increase of inflammatory action take place, sufficient to induce degeneration, these membranes may soften, and pus may form in the subdural space, followed by disintegration of the pia mater and superficial ulceration of the brain tissue. Two conditions may thus result: (*a*) if the pia is intact, a *subdural abscess* may form, or (*b*) if the pia softens, *cerebral ulceration* takes place, and the disintegrating products are confined to form an abscess on the brain surface.

(4) Should the infection penetrate the capillary network on the inner layer of the dura mater, the whole subdural space is open to rapid invasion, and a *leptomeningitis* is apt to ensue.

(5) Leptomeningitis and *cerebral abscess* may be formed also by *direct* extension, by thrombosis extending into the pia mater or the brain.

(6) Should an inflammatory process in the mastoid bone be in contact with the *sigmoid sinus*, the internal surface becomes inflamed and a *thrombus* is formed in it, the slowness of the blood current at this spot favouring its development. The thrombus is generally infected with organisms, and may break down into pus.

(7) When this happens, the *cerebellar* veins may become affected and so convey organisms to the cerebellum, where an *abscess* will be formed.

(8) In exceptional cases a cerebellar abscess may arise *directly* by infection travelling backwards along the facial or auditory nerves.

Pachymeningitis, with or without extradural abscess, originates most commonly from contusions of the skull, followed by a localised osteomyelitis, or from infection of a blood clot (*pachymeningitis hæmorrhagica*). It may not commence for several weeks, and is generally subacute or chronic in character.

Symptoms.—It begins with an aching pain at the seat of injury, and spreads over the head. The pain gradually becomes more pronounced, and may be accompanied by a feeling of weight. If the region of the injury be examined, a swelling may be observed which is sometimes quite slight; but it is tender to touch and pits on pressure (*Pott's puffy tumour*), and it indicates localised osteomyelitis. If the bone be exposed at this place, it is seen to be white or discoloured and dead-looking. The patient is irritable and restless, and suffers from insomnia, mental depression, and sometimes fainting fits. There is generally giddiness on movement, and sometimes vomiting. The temperature is variable, but is usually raised; and the pulse and respiration increased according to the severity of the general inflammation. The eyes show no alteration, unless the lesion is in the parieto-occipital region, when there may be contraction of the pupil or choked disk in the fundus. The muscles may show spasms or paralysis if the cortex is pressed upon.

Prognosis.—Once the disease is established, it is progressive and, unless relieved by operation, usually fatal.

Treatment.—As soon as the local signs are detected, the skull should be exposed and an opening made where the disease is chiefly situated. If this is done before the inflammation spreads to the pia mater, or the abscess bursts, the result is usually very satisfactory.

Cerebral abscess starts most commonly from middle ear disease, and is subacute as a rule. If it lasts more than four or five weeks, it is classed as chronic. The acute form, arising from traumatic infection a week or ten days after an injury, usually runs a rapid course, and is nearly always complicated by acute *encephalitis* (inflammation of meninges and brain tissue). The ordinary form is preceded by a latent period, generally of a week or two, but sometimes lasting for years.

The **symptoms** are not at first well marked, but are indicative of septic absorption, *i.e.* fever of a typhoid type, with discomfort in the evenings, lack of appetite, constipation and chills. The tongue, at first clean, becomes dry and foul; and the temperature, from being high, falls to subnormal. Besides this, the mental faculties become obscured, the patient becomes irritable, listless and confused, and cannot perform any act requiring an effort of mind or body. The abscess being encapsuled does not extend regularly, but by steps, and these are marked by sudden increase in the symptoms, notably of pressure. Headache, increased by percussion, and drowsiness are common ; and vomiting, unconnected with taking food, but excited by quick movements, becomes a prominent feature. Optic neuritis is not usual, but if present in one eye it indicates pus on the same side. Should the abscess spread outwards to the sensori-motor area of the cortex, it will cause local pressure, and lead to spasms or paralysis of the corresponding parts of the body. Should it burst into the lateral ventricle, sudden death is the result ; if into the subdural space, it produces a generalised meningitis on one half or the whole of the surface of the brain.

Cerebellar Abscess.—If the abscess forms in the cerebellum, there may be staggering gait, and the patient is apt to fall towards the affected side. If he is confined to bed, weakness of the limbs on the same side may be noticed. There is often a deviation of the eyes—the eye on the affected side being turned upwards and outwards, and that of the opposite side downwards and outwards. Nystagmus is often brought on by attempts to turn the eyes, and optic neuritis is common. The basal nerves, 5th, 6th, 7th, and 8th, are apt to be involved.

Treatment.—In *traumatic* cases, the wound should be opened up and the surface of the brain exposed whenever retention of pus is suspected. The abscess is often superficial, and is then easily found and drained. Abscess in the deeper parts is indicated by bulging of the brain into the wound and absence of pulsation. The brain should be punctured with a brain trocar (*Macewen's*), which is a blunt-pointed hollow needle of the calibre of a goose-quill furnished with several lateral eyes near the point. If pus is not found at once, the trocar should be withdrawn and passed in again at slightly different angles until the abscess is reached. No irrigation is necessary, but, as the walls of the track fall together, a drainage tube should be inserted. It should be fixed with a pin or stitch to prevent it passing too far inwards and doing damage ; and it may be shortened as the abscess cavity diminishes, but the wound must be kept open until suppuration ceases. If an osteoplastic flap has been made for exposing the abscess, an opening must be cut out of the edge to permit the passage of the tube. Should there be a reaccumulation of pus and recrudescence of the symptoms, the track should be opened up by inserting a dressing forceps and opening the blades as it is withdrawn.

In *otitic* cases the sites must be diagnosed by signs of local pressure.

(*a*) Abscess of the *tempero-sphenoidal* lobe is usually situated near the tegmen tympani, and may be reached by an opening in the bone $\frac{1}{4}$ inch behind and $\frac{3}{4}$ inch above the centre of the external auditory meatus.

(*b*) In *cerebellar* abscess, the bone should be perforated $1\frac{1}{2}$ inches behind and $\frac{1}{4}$ inch below the meatus.

(*c*) As the majority of otitic abscesses are in one of these two places, and as it is frequently impossible to be sure which, the surgeon must be prepared to explore *both*. Hence it is recommended with good reason to combine the operations. A trephine opening is made $1\frac{1}{4}$ inches behind the meatus and $\frac{1}{4}$ inch above it, thus exposing part of the lateral sinus and above it the dura mater over the tempero-sphenoidal lobe. If pus is not found there, the opening in the bone is enlarged downwards and backwards with a gouge-forceps, until the lower edge of the sinus is passed, and the dura mater over the cerebellum is exposed, and can readily be explored for pus (*Dean*). The brain and cerebellum may be explored also by enlarging the openings made for exposing the middle ear and mastoid in the radical treatment of otitis.

(*d*) Abscess in the posterior part of the *frontal* lobes may be reached through an opening in the temporal region over the site of the abscess.

(*e*) Abscess in *other parts* of the brain must be located by pressure symptoms on the sensori-motor areas, and exposed according to the rules laid down for mapping out these regions.

Leptomeningitis runs an acute course, and is generally fatal in a few days. It begins with chills and headaches, and intolerance of light and sound. The temperature rises rapidly, the pulse becomes quick and full, and there is generally troublesome beating of the carotids. The tongue is clean, but there is distressing thirst, with nausea, and often retching or vomiting. The patient is restless and sleepless, but later becomes dazed and delirious, and often gives a sharp cry.

The eyes are glazed and the pupils contracted. As the effects of pressure become more pronounced, the stupor increases, with dilatation of the pupils, slow pulse and stertorous breathing, which often changes to the Cheyne-Stokes type. The tendon reflexes are much increased, and local pressure may give rise to rigidity or twitchings, or some of the muscles may be paralysed. If the base is chiefly affected, there is stiffness of the neck, and retraction of the head, and optic neuritis can be seen. If the inflammation lasts till pus becomes formed, the stage is marked by the occurrence of rigors. The terminal symptoms are rapid and irregular pulse, irregular breathing, which gradually ceases before the pulse, and increasing coma leading to death.

Diagnosis.—Occasionally similar signs, even to coma, arise from intracranial absorption,—from acute suppuration in the middle ear, or from tight plugging in cases of suppuration in a thrombosed sinus. In these cases diagnosis is made by the absence of the rigidity and twitching of the muscles, the stiffness of the neck, or the increase of tendon reflexes, and by relief of the symptoms on puncture of the tympanic membrane, or removal of gauze packing. In all cases of doubt, lumbar puncture should be made and the cerebro-spinal fluid examined. This is a valuable method for distinguishing *epidemic cerebro-spinal meningitis*; and repeated punctures are considered to be the best form of treatment for that disease.

Treatment.—So far, no treatment has been of any avail. Large openings have been made in the skull for drainage, and the surfaces have been flushed out, without giving relief.

Thrombo-phlebitis of the venous sinuses occurs far more frequently from middle ear disease; but it can arise also from extension of inflammatory processes along the vessels communicating with the scalp and face. The **symptoms** are essentially those of pyæmia, sudden rises of temperature (104°-106°), with rigors and rapid pulse (120-140), followed by equally sudden remissions accompanied by profuse sweating. Sometimes granulations spring up in the sinus, and so block the way to further extension of the infection. As the disease progresses, it takes the character of one of three types: (*a*) the *pulmonary*, in which abscesses and gangrene occur in the lungs; these are indicated by sudden pains in the chest, and cough, with "prune-juice" sputum; (*b*) the *abdominal*, in which the digestive system chiefly is disordered, the tongue dry, the breath foul, respiration rapid, diarrhœa profuse (with "pea-soup" stools), and frequent vomiting. A petechial rash usually appears on the abdomen, and resembles that of enteric fever; (*c*) the *meningeal* type, in which the symptoms point to lepto-meningitis. External evidences of thrombosis are observed only in that of the *lateral* or *sigmoid* sinus: none of the others showing any constant sign which is characteristic. When the sigmoid is affected, there is often œdema and pain behind the posterior part of the mastoid process (cf. mastoiditis, in which the œdema is over the process itself). The inflammation often extends into the jugular vein and gives rise to a cord-like swelling in the neck, which is very tender to touch. The head is restrained in its movements, and is generally turned to the diseased side in order to relieve the tension of the sterno-mastoid muscle. In rarer cases there may be pressure on the vagus nerve, causing hoarseness, dyspnœa, and slowing of the pulse; and still more rarely, dysphagia has been noted as the result of pressure on the glossopharyngeal nerve. If the disease in the jugular is allowed to progress, the thrombus may break down and form an abscess, which bursts and leaves a foul suppurating sinus in the neck. Metastatic abscesses may form in any part of the body.

Diagnosis, from cerebral abscess, by its typical pyæmic signs; from enteric fever, by the negative reaction to Widal's test; from miliary tubercle, by absence of evidences of tubercle in the choroid, or in the cerebro-spinal fluid aspirated by lumbar puncture; from endocarditis, by prominence of cerebral disease; and from malaria, by absence of plasmodia in the blood.

Treatment.—As sinus thrombosis is usually dependent on disease of the mastoid, it is advisable to treat the primary focus of infection first, *i.e.*, the mastoid and the middle ear from which the disease originates; and from that to proceed to the sinus. The mastoid may be reached most conveniently and safely by making an opening into the antrum through the suprameatal triangle, which lies $\frac{1}{4}$ inch behind the meatus at the level of its upper edge. This may be made with a gouge and hammer, but best of all with a burr and dental or other engine: trephines are apt to wound the sinus, and should not be used for this purpose. The opening is easily enlarged, and the mastoid cells, which are usually diseased, should be scraped out. Care must be taken during these manipulations not to wound the facial nerve as it lies in the aqueduct of Fallopius. If the middle ear disease is still active, the opening should be extended into it by removing the posterior wall of the bony meatus; and the ossicles and all granulations should be cleared out. The sigmoid sinus is next reached by extending the mastoid opening downwards and backwards; or directly, by making an opening through the bone in the line of the sinus, $\frac{3}{4}$ inch behind the meatus. Here it must be freely exposed, and all granulations removed from around it. Thrombosis is verified by palpation, or in doubtful cases by inserting a fine trocar. The most radical treatment then is to ligate the jugular vein in the neck about the level of the hyoid bone, and cut it across above this point, clamping the cut end with forceps meanwhile. The sinus is next split open and the thrombus scraped out with a narrow spoon, and syringed through from the jugular opening. The cavities are firmly packed with iodoform gauze, and bleeding is thus prevented. The wound is kept open and allowed to heal by granulations. (See also *Mastoiditis.*)

Tubercular disease of the brain is usually fully referred to in medical works, but is described here on account of its close relationship to other cerebral affections. It takes either the form of a localised nodule (for which see *tumours*), or of a disseminated meningitis, which occurs most commonly in children, and this may spread to the membranes of the spinal cord. It is usually secondary to some other tubercular lesion in the body,—in the lungs, mesenteric glands, joints, or the ear,—but sometimes no evidence of such can be found. Acute fevers or a blow on the head may act as exciting agents. The tubercles are either scattered as minute (miliary) points over the membranes, especially at the base and along the sulci, and the fluid is scanty; or they are few in number, but accompanied by an abundance of a gelatinous opaque fluid (giving rise to the condition formerly spoken of as *acute hydrocephalus*). The choroid plexus is sometimes involved and becomes engorged, and the foramen of Majendie may become blocked.

Symptoms.—After a period of indefinite ailing, the child becomes lethargic and disinclined for play. He is easily tired, but in bed he is restless, grinds his teeth, and often wakes in terror. During this time the appetite fails and wasting comes on. The final stages usually begin with vomiting or convulsions.

Photophobia and headache become constant, and the child puts his hands to his head and often emits the characteristic cry. The mind becomes clouded and unconsciousness supervenes. The pupils are contracted, and the fundus usually shows choked disk, and sometimes tubercles in the choroid. The temperature is raised (101°-103°); and the pulse becomes slower as pressure increases. The bowels are generally constipated, but the tongue remains clean. The abdomen is indrawn, and the head retracted. Light stroking on the skin with the nail may elicit *tâche cérébrale* (a broad red line, which fades slowly). Cheyne-Stokes breathing comes on, and stupor deepens to coma and death.

Treatment, as a rule, is confined to general measures. Pressure may be relieved by lumbar puncture if the foramen of Majendie is not occluded. Openings into the skull cannot be expected to do more; but if any local nodule is seen on trephining it should be excised.

Epilepsy occasionally follows a cranial injury, but not till a considerable time after it, sometimes even years, and never before cicatrisation has taken place. It is associated with three conditions: (1) cicatrices of the *scalp*, or even of other parts of the body, involving nerve fibres in the scar, from which the fits seem to start; (2) depressions or fractures of the *skull*, with thickening of the bone or membranes: and (3) cicatrices, foreign bodies, degenerative foci, cysts or tumours of the *cortex*. Very often a history can be elicited of a nervous disturbance of some kind or other predisposing condition. The form of fit is peculiar, and is known as *Jacksonian epilepsy*. It begins as a twitching of a single muscle or small group, such as that of a finger: from that it spreads to the whole limb, half of the body, and finally the whole body, ending as a general convulsion, at first without but latterly accompanied by loss of consciousness.

Prognosis.—If the disease is allowed to progress without treatment, it is apt to become habitual, and no longer curable by operation. Hence any surgical measures should be taken early. The cases of epilepsy curable by operation are not very many; but if there is a clear history of injury; if there is any scar, depression or elevation on the skull, the result of injury; if pressure on the part tends to excite or to control a fit: or if pain, tingling or any other form of aura be felt at such a spot previous to a fit: and especially if the history of previous nervous disturbance can be excluded, then the prospects of cure are more favourable. General idiopathic epilepsy is not improved by surgical treatment.

Treatment.—The focus of irritation in the sensori-motor area should be located and exposed, and any abnormal tissue removed (see *Tumours*). As intracranial tension is generally increased during a fit, it is sometimes necessary to relieve this by leaving a deficiency in the skull; but reversely, improvement sometimes follows if a defect in the skull is closed by a bone flap. Irritable scars on the scalp or elsewhere should be excised.

Tumours in the brain comprise gliomas and other simple tumours; sarcomas, gliosarcomas, and psammomas (either encapsuled or diffuse), and secondary carcinomatous growths; and also included in this category are cicatricial thickenings, syphilitic and tubercular nodules, and cysts. They may arise either from the brain itself or from its membranes.

The **symptoms** are those (1) of general cerebral *compression* and (2) of *local* irritation or destruction. Of the first, the most prominent are persistent and severe headache, and usually tenderness on percussion over the site of the tumour; vomiting, unconnected with taking food, and even with an empty stomach (spoken of as *cerebral vomiting*); and choked disk in the early stages of tumours in the cerebellum and frontal region, and in the later stages of those of the sensori-motor areas. There is often a disturbance of intellect, and the patient becomes dull and stupid, and is slow in answering questions, or refuses to speak. In the later stages there is often much wasting, from the persistent vomiting and want of sleep. The second group consists of *monospasms* (spasms of isolated groups of muscles), often passing on to general convulsions, and of *monoplegias* (paralysis of isolated groups of muscles), which similarly may pass on to hemiplegia involving the half of the body. As regards localisation of the lesion, monoplegia is much more reliable as a guide to the site, since it implies destruction of a definite area; the spasms on the other hand may be set up by irritation starting at some distance from the centre of the tumour, *e.g.* at its extreme limits.

Diagnosis must be made in the first instance from uræmia, lead poisoning, and other conditions which cause cerebral symptoms; and from hysteria, general paralysis, and disseminated sclerosis; from meningitis and cerebral abscess, in which choked disk is less often seen, and where ear disease is frequently present. The *nature* of the tumour is often obscure: except tubercular tumours which form about the half of all, and syphilis which also is common, the most frequent are sarcomas, next the gliomas and cysts, while the others are less often met with. Circumscribed tubercular and syphilitic nodules are seldom present without other confirmatory signs in the body, and they remain for a long time quiescent and localised, but may gradually or suddenly take on a more diffuse character; when this happens they should be removed by operation. With cysts there may be a history of injury either recent or at birth (traumatic and porencephalic cysts); but they may be due to softening of a sarcoma or to cysticercus. The *site* is determined by local symptoms (*vide* p. 245). Tumours in the frontal region are often latent throughout, unless they encroach on the speech centres. In the temporal region, the most common site, they are more easily located by their effects on the sensori-motor centres. Occipital tumours are sometimes determined by the onset of crossed homonymous hemianopsia. Cerebellar tumours may give rise to vertigo and staggering gait; and vomiting and choked disk are prominent signs. Often, unfortunately, decisive indications are absent, especially if the tumour is seated deeply, and the bare fact that a tumour is present is all that can definitely be said. The *depth* can be gauged to some extent by the effect on the muscles, if it lies near the motor centres. Tumours in the subcortical layers are more apt to cause paralysis; while those in the cortex itself are more likely to cause disturbance of the muscle-sense, and there is more liability to tenderness on percussion.

Prognosis is very unfavourable. Simple and tubercular tumours sometimes enlarge very slowly or even become stationary: but others are soon fatal unless relieved by operation. Syphilitic masses can sometimes be diminished by iodides and mercury; but they are often resistant to medical treatment.

Treatment.—*General*: In most cases iodides or mercury should be tried, on the chance that the tumour is syphilitic. Headache may be relieved by opium, or less certainly, by phenacetin; and general pressure symptoms are sometimes relieved by lumbar puncture.

Operative: When a tumour can be clearly located, it should be excised, if it can be reached without immediate danger to the patient's life. By employing Wagner's method, the opening into the skull may be made very free, and a large area of the brain exposed. The incisions into the brain should be made perpendicularly to the surface, and a blunt-edged knife (such as *Horsley's*) should be used; by this means comparatively little damage is done to the blood-vessels of the adjacent tissue, and the chances of haemorrhage and necrosis are slight. If the tumour cannot be located before operation, or discovered after the skull is opened, or even if it cannot be radically removed, intracranial pressure is often much relieved by the operation; and this may be enhanced by leaving out a piece of the bone in closing the wound.

Chronic hydrocephalus is distension of the head by fluid, sometimes between the brain and skull, but more commonly in the lateral ventricles. It is usually congenital, and seems to depend on obstruction of the veins of Galen or on interference with free communication of the intra- and extra-cerebral fluid at the foramen of Majendie.

Symptoms.—In the ordinary form the head enlarges uniformly, and the cranial bones become thinned and widely separated at the vertex. The hair on the scalp is scanty, and the veins are dilated and prominent. The body becomes wasted, and the muscles lose their power to support the heavy head. Meanwhile, the mental condition deteriorates, and epileptic convulsions may ensue. Death occurs from marasmus or from coma. If the disease becomes arrested, the head remains large, and there is often some mental deficiency from atrophy of the brain; and epileptic fits may occur from time to time.

Prognosis is unfavourable; death is the usual result.

Treatment.—Operative measures consist of lumbar puncture; or, if the foramen of Majendie is obstructed, of direct tapping of the lateral ventricles. Continuous drainage externally has been tried, but always with fatal results. Proposals have been made to establish a fistula between the spinal arachnoid and the free abdominal cavity, but so far without success.

Microcephaly is a condition met with in idiots, in which the skull is abnormally small. It is probably dependent on a want of development of the brain. Though formerly operations were done on the skull to give more room for expansion, on the supposition that early closure of the sutures was the cause of the idiocy, the disease is not one in which improvement is obtained by operation.

Cephalocele is a congenital cyst presenting through a hole in the skull, generally at the occipital region or near the glabella. It may be flat and sessile, or round and pedunculated, and consists of a cyst derived from and in most cases in communication with the lateral ventricle or other intracranial cavity. The wall is composed of skin, thickened arachnoid and a layer of nerve tissue derived from the brain, and lined with a membrane similar to, and continuous with, the ependyma of the ventricles. The pericranium, bone, and dura mater are absent or represented by fibrous tissue around the orifice in the skull. In some cases the layer of nerve tissue is thick and occupies the greater part of the swelling; in others, where it is rudimentary and where communication with the intracranial cavities has been obliterated, the cyst appears to arise from the meninges—*meningocele.*

Prognosis.—The nearer it approaches to the latter type, the more amenable it is to successful treatment. If there is much brain tissue in the tumour, the skull is always microcephalic, and the child soon dies; any operation only tends to hasten death, usually by inducing hydrocephalus.

Treatment.—The cyst may be removed by excision; no method of iodine injection or compression being either efficient or safe. An eliptical incision is made round the base, and the skin separated from the pedicle; the neck is clamped and the cyst cut off; a double row of sutures is put in the stump, so as to close the opening and turn in the edges. The hole in the skull may be closed by a König-Müller flap if material is readily available in the vicinity; but once the cyst is removed, there is often a tendency to spontaneous closure of the bone.

CHAPTER II.

SURGERY OF THE SPINE.

INJURIES OF THE SPINE.

Contusions and **Sprains** of the vertebral column are common injuries resulting from falls, crushes, or violent twists. The *former* affect chiefly the superficial structures, and may give rise to extravasations of blood; and are of importance mainly because they may simulate fractures and dislocations, or may be accompanied by injury to the cord from concussion. In the *latter*, the ligaments, muscles and fasciæ are overstretched or torn, and the intervertebral disks may be separated. The favourite localities for sprains are the cervical and lumbar regions. There is usually considerable hæmorrhage, which may lead to extravasation into the spinal canal, causing pressure on the cord. The blood may become absorbed or organised, or undergo suppuration, in the latter case generally with a fatal termination. The remoter results, apart from lesions in the cord, are chronic inflammatory thickening about the vertebral joints, and stiffness or shortening of the muscles and ligaments from non-use or special postures.

Symptoms are pain and stiffness on movement; effusion causing localised swelling, and at a later stage ecchymosis: and tenderness on pressure extending over a wide area. In sprains of the neck, the patient often holds the head in his hands to prevent movement. In those of the lumbar region, the body is often kept bent, with the legs curled up against the trunk; and there may be difficulty in moving the legs, or in passing urine, but these effects soon pass off.

Treatment consists of rest in bed, and hot fomentations or belladonna plasters to the back. When all active irritation has subsided, the resulting stiffness may be treated by forcible movements of the back, if necessary under anæsthesia, and by douching, massage, and exercises; the localised pains being relieved by small blisters.

Wounds of the spine, with the exception of operative or gun-shot wounds, are very rare. They are of importance chiefly on account of their effects on the cord or its membranes.

Fractures of the spine are usually accompanied by dislocations of some degree. *Partial fractures* from direct violence comprise fractures of the spinous processes, laminæ, transverse processes, or the bodies of the vertebræ. The *symptoms* are essentially those of contusions or sprains, sometimes with crepitation or mobility of the fragments; and the *treatment* is practically the same; but if a fragment presses on the cord, it should be removed by laminectomy.

Dislocations are usually combined with fractures, but *partial* dislocations (*subluxations*) sometimes occur in the middle cervical region, or between the head and the atlas, or the atlas and axis. They consist in the upper articular process overriding the lower one, so that the joint becomes locked in a false position. The *signs* are pain and stiffness in the neck; fixation of the head in a bent and rotated posture; and occasionally irregularity of the cervical spines. The history of injury may make those conclusive.

Treatment consists of careful reduction by strong and steady extension under anæsthesia; any sudden manipulation may lead to immediate death from nipping of the cord. If reduction is impossible, the neck must be immobilised with plaster-of-Paris or a well-fitting support.

Fracture-dislocation is displacement of two or more vertebræ from one another, combined with fracture of the parts which interlock, and sometimes of the bodies. It occurs in accidents from falls, crushes, collisions, "running-over," collapse of buildings, etc. The commonest sites of this injury are the lower cervical region, and about the junction of the dorsal and lumbar vertebræ. When the spine is bent backwards, the anterior ligaments are torn asunder, the posterior parts crushed together, and the spinous processes and arches are often broken across; when it is bent forwards, the bodies of the vertebræ are crushed together, and the arches and spinous processes torn asunder. The upper segment of the spine is generally dislocated in front of the lower; and the articular processes override or are fractured. The *cord* becomes crushed in greater or less degree between the body of one vertebra and the arch of the one above; and the spinal nerves are often crushed as they emerge from the intervertebral foramina. Hæmorrhage may take place into the canal, either on the outside or the inside of the spinal dura mater.

Symptoms.—There is usually some shock from the injury or from hæmorrhage; pain on pressure and movement, confined mainly to the region of the lesion; local swelling; and sometimes unevenness of the spines. The important symptoms, however, are those due to the injury of the cord. When the cord is *completely* severed, there is absolute paralysis and anæsthesia below the parts corresponding to the level of the injury (*paraplegia*). The limbs are flaccid at first; and all the parts directly innervated from the regions destroyed in the cord undergo atrophy,—the reflexes are lost, trophic changes follow, and reaction of degeneration appears in the muscles. The other parts below the lesion ultimately show a certain amount of recovery; and reaction of degeneration does not appear until *secondary degeneration* occurs in the cord, accompanied by clonic or tonic spasms ("*late rigidity*"). The reflexes, however, in spite of physiological reasons to the contrary, remain in abeyance, especially the deep ones; and, if the superficial ones return at all, they are so irregular as to be valueless for purposes of diagnosis. The sphincters and muscles of the bladder and rectum are paralysed: the urine is at first retained until the bladder is distended, and, when the sphincter is overcome, it dribbles away, and the fæces accumulate in the rectum and are passed involuntarily at intervals. There is often involuntary erection of the penis (*priapism*). Sensation remains completely abolished below the injury; but the parts immediately above it are hypersensitive, and this condition may give rise to a zone of pain round the body ("*girdle pain*"). Trophic changes soon appear,—bedsores arise on very slight irritation, and spread with great rapidity; the bladder mucous membrane becomes weakened and often desquamates, and cystitis usually comes on sooner or later from septic infection; and absorption of toxic products or direct infection may result in inflammation of the kidneys. The temperature may be normal, very high, or very low; but it usually varies with the degree of toxic absorption: and the pulse is generally in accord. The mind is not in any way impaired, unless from cerebral concussion or toxic delirium.

The *local symptoms* in complete division of the cord vary with the level. Below the 2nd *lumbar* vertebra, the cord escapes, and any nervous lesion is due to injury of the *cauda equina*—*i.e.*, paralysis and anæsthesia of the lower limbs and pudic area, and of the bladder and rectum. Complete paralysis is very rare in this region; and a certain amount of recovery of the limbs may be looked for. In the *dorsal* region (2nd–10th dorsal) there is paralysis of the abdominal muscles, in part at least, with flaccidity of the belly walls, and this may lead to tympanitis from absence of controlling pressure on the bowels, and to retention of fæces from inability to express the contents of the rectum. In addition, the lower ribs are no longer fixed by the recti, and the intercostals have therefore little power in aiding respiration; and this may lead to difficulty of breathing. Injury about the *9th dorsal* entails anæsthesia below the navel; above the *6th dorsal* usually results in priapism, from reflex irritation by catheters, etc. In injuries of the *cervical* enlargement (3rd cervical—2nd dorsal) there is paralysis of the upper limb, and of the intercostals, and breathing becomes entirely diaphragmatic. Severance at the *upper cervical* region is generally immediately fatal from injury to the phrenics; but even if it is not complete, there may be gradually increasing paralysis of the respiratory muscles, and asphyxiation. In this region, too, injury to the sympathetics may cause irregularity of the pupils and of sweating. Death generally supervenes in a few days at furthest, from hæmorrhagic pressure or from myelitis.

Chipault gives a ready and fairly reliable *rule for finding the position* of the spinal roots from palpation of the spinous processes:—in the cervical region, add one to the number of the spine; in the dorsal, add three, and continue this as far as the tenth; the lower part of the eleventh dorsal and its interspace correspond to the last three lumbar roots, and the twelfth dorsal and its subjacent interspace to the sacral roots.

Prognosis depends on the degree of destruction of the cord. When it is only partially destroyed, the immediate signs are much less clearly marked; and the prospects of recovery are much greater. If the injury is confined to one side of the cord, the corresponding limbs are of course paralysed; but the bladder, rectum, diaphragm, heart, etc., which have their nerve supplies from both sides, are not so gravely affected. The great majority of cases with *extensive* destruction, however, die sooner or later; generally speaking, the higher the lesion, the earlier the end. Even in lesions of the lower part, septic absorption or ascending myelitis may carry off a patient during a long convalescence.

Death occurs from (*a*) injury to the phrenic nerves or their roots, from violence or hæmorrhage; (*b*) pulmonary congestion, from irregular or insufficient action of the lungs or bronchial mucous membrane; (*c*) septic absorption from bedsores, or kidney or bladder inflammation; or (*d*) rapidly spreading myelitis or meningitis.

Treatment.—In all cases the patient is laid on a flat bed, care being taken not to increase the displacement and so add to the crushing of the cord. When the cord is obviously *not* injured, an attempt should be made at reduction by firm extension with weight and pulley; the bones may slip into place, since the ligaments are torn. Whether reduction is successful or not, the spine should be immobilised in a plaster case applied to the back, while the patient is turned over on his face. This may be changed for a complete plaster jacket or strong corset when the parts are more consolidated. If the cord is *completely* crushed, no local treatment is of any avail; and the chief objects are to attend to the bladder and bowels, and to prevent bedsores and cystitis. Here a water-bed should be used; and the skin must be kept scrupulously dry, and hardened from time to time with spirit; if bedsores develop, they must be treated antiseptically (*vide* p. 22). The bladder is emptied twice daily with a soft rubber catheter; this should be sterilised by steam or boiling water at each passage, and lubricated with plain boiled oil, as glycerine or carbolic oil are too irritating to the mucous membrane. The penis also must be washed and dried each time. If cystitis comes on, it may be allayed by the internal administration of helmitol, and by washing out the bladder with boracic lotion. The bowels must be regulated with laxatives to prevent the accumulation of scybalæ; and if diarrhœa ensues, it must be subdued with opium. Spasms of the legs may be controlled by light weights attached over pulleys to the feet. When the cord is *partially* injured, all movements must be carried out with great gentleness, as very little increase of displacement may make the destruction complete; where reduction is not possible, pressure on the cord may be relieved by laminectomy; but this should never be employed until it is seen how much of the paralysis is temporary and how much permanent. The treatment otherwise is that of the symptoms as above.

Secondary effects of spinal injuries.

(*a*) **Concussion of the Cord.**—This can only occur from severe blows, as the cord is so well supported by its tough membranes that slight violence does not affect it. The *symptoms* are sudden and complete loss of function below the point of injury, usually accompanied by general shock, with low temperature, and weak and rapid pulse. The sphincters and reflexes are paralysed; but priapism does not occur. These symptoms usually pass off completely; but sometimes there is permanent impairment of the functions according to the amount of organic alteration in the cord, due to laceration or hæmorrhage. There is often a certain amount of neurasthenia. In a few cases death occurs, especially when the injury is in the upper cervical region. *Treatment* is that of contusions of the spine, with prolonged rest.

(*b*) **Hæmorrhage** between the bone and dura mater, or the dura and cord. The chief *symptom* is spinal irritation, followed by paraplegia, generally ascending the cord as the canal fills up with blood. In some cases where the blood is extradural, the symptoms may be more localised. Intramedullary hæmorrhage has the characters of concussion and laceration. *Diagnosis* is made by the gradual onset after an interval, and the progressive nature of the symptoms, with the absence of signs of myelitis or meningitis. *Treatment*—rest, and in certain cases, laminectomy for the relief of pressure.

(*c*) **Spinal meningitis**, usually acute, from septic infection attacking a blood effusion or the injured tissues around the cord. The *symptoms* are sudden onset of pains in the back, usually accompanied by rigors; painful cramps in the limbs: extreme hyperæsthesia; and reflex excitability. Rapid emaciation and sleeplessness supervene, paraplegia generally follows, and death is the usual result. *Diagnosis* may be made certain in many cases by lumbar puncture and examination of the cerebro-spinal fluid. *Treatment* is that of any special symptoms. In some cases the inflammation becomes chronic or localised; in which cases it may be possible to evacuate an abscess and so give relief (*see* also a work on medicine).

(*d*) **Myelitis**, either *simple traumatic* inflammation of the cord due to direct injury by crushing, concussion, or hæmorrhage: or following extension of *infection* from the meninges. *Acute myelitis* resembles meningitis of the cord, but the paraplegic condition comes on relatively sooner, and is much more prominent; indeed, the irritative stage sometimes passes so rapidly that it may be overlooked. The condition of the reflexes, and of the bladder and rectum, depends on the amount of destruction in the cord. High fever is often present, especially when the cervical region is implicated. Death results from spread of the disease to the respiratory centres. *Chronic myelitis*, which is generally of traumatic origin, gives rise to motor and sensory disturbances, and does not differ essentially from that due to general conditions described in medical books.

(*e*) **Inflammatory thickening** or **callus-formation** around the cord may lead to pressure. The *symptoms* are at first those of irritation, coming on at a long interval after the injury, followed by paralysis as the cord becomes destroyed. It is *diagnosed* by the evidences of injury; and localised by the focal symptoms, or by scars, projections, etc. *Treatment* consists in relieving the pressure by laminectomy, removal of callus, and loosening of cicatricial adhesions.

(*f*) **Traumatic neurasthenia** ("*indirect concussion of the spine*") is a condition of nervous prostration which is seen after sudden jars to the body, both severe and slight. From the fact that it is so often met with after railway collisions, it is sometimes spoken of as "*railway spine.*" It may be accompanied by organic changes in the cord (concussion proper): but it is even more frequent amongst those in whom little or no evidence of such lesions can be detected; and it is thought that the complete rest necessary after more severe injuries has some influence in warding off this condition; it occurs also chiefly amongst those who have a predisposition to nervous disturbances.

Symptoms.—As a rule the principal results are from exhaustion of the spinal centres, with weakness and irritability. In the more typical cases the patient at first feels fairly well until the excitement of the accident passes off, when the effects of sudden fright and violent shaking or wrenching make themselves felt. The patient either collapses suddenly in a short time; or after an attempt to return to his ordinary occupation, he is obliged to give up work or even take to his bed on account of his increasing disablements. *Motor* and *trophic* functions are often only slightly affected. In aspect the patient is pale and anxious-looking. He is weak and easily tired, his reflexes are exaggerated, his muscles tremulous, and there may be even ataxia; the sphincters are relaxed, and there is sometimes excessive sweating on slight exertion or excitement. The temperature is often subnormal. The *sensory* disturbances are pain in the back, neuralgia, numbness, pins and needles, or hyperæsthesia, disturbances of vision, and noises in the ears. The *mental* condition is often the most prominent. He suffers from insomnia, loss of memory, and mental depression, which sometimes resembles hysteria; he is unable to concentrate his attention on any work demanding thought or effort, or to sustain a conversation; he cannot bear bright lights or loud noises, and is easily startled. Agitation of any kind, or the constant worry of an action for damages, seem to aggravate the symptoms. When such an action is finally settled, the mental condition improves rapidly, while the bodily ailments are slower in disappearing; if there are organic changes in the cord, the improvement is of course still slower.

In other cases the symptoms may not appear for weeks or months, and the weakness and other nervous disturbances come on gradually. Motor and sensory functions become deficient or lost, and there may be want of control of the bladder, and loss of sexual function. These are due probably to progressive inflammatory changes. The prognosis in these latter cases is very unfavourable; the patient becoming either crippled or a confirmed invalid.

Diagnosis must be made between cases with and without lesions in the cord. Careful examination must be made of the muscular system, and any positive evidence of paralysis or absence of reflex noted; whereas alterations of sensation seldom give much information.

Treatment.—In the absence of any organic damage, the chief treatment is rest of the body and mind, nourishing and easily digested food, and, if necessary, nerve sedatives. These should always be followed if possible by change of scene, with gentle and regular exercise in the open air, and agreeable diversion of an unexciting kind. Pain in the back, which is often late in disappearing, may be relieved by douching and massage, and sometimes by counter-irritation. For those cases with organic lesion, *see* concussion of the spine.

Laminectomy is the removal of several of the laminæ and spinous processes above and below the injured part, in order to expose the cord for removal of tumours, etc., and to relieve pressure. An incision is made over the spines to be removed, and the soft parts pushed back with a periosteal elevator. The laminæ are cut through on each side with Hey's or Gigli's saws, and removed together in one piece, or separately. Some surgeons prefer to make a flap incision of the skin in order to avoid leaving the suture over the opening into the spinal canal; while others make an osteoplastic flap of laminæ, skin and connective tissue, and replace the bones at the close of the operation, this latter method, however, is only suitable when laminectomy is done for the removal of tumours and the like, and not for displacements of the vertebræ. The operation may be performed with a fair prospect of success in the following conditions:—(1) in injuries of all sorts in the lower lumbar region; (2) in subluxations of the neck, which cannot be reduced; (3) in all fractures of the arches alone, when the cord is pressed upon; (4) where paraplegia comes on slowly after an interval, either from hæmorrhage or inflammatory thickenings; (5) for tumours of the spinal canal, meninges or cord; (6) for relief of localised abscesses in the canal; (7) for kyphosis due to tubercular disease of the vertebræ, when pressure on the cord cannot be relieved by extension. It should *not* be attempted (*a*) where the cord is completely severed,—no benefit is obtained, and the patient is subjected to needless shock; (*b*) if acute myelitis or meningitis have set in; (*c*) in temporary paraplegia, *i.e.* until all conditions which might arise from temporary disturbance have disappeared or become established: thus in no case, except perhaps in hæmorrhage without displacement, should the operation be done before ample time has been allowed for the symptoms to subside.

Suture of the cord, though recommended by some surgeons on the basis of experiments on animals, is not likely to result in any improvement in these circumstances. When the injury is confined to the *cauda equina*, however, an attempt should be made to suture all the torn ends.

Coccydynia (or *coccygodynia*). A blow or fall on the coccyx may fracture it, or rupture some of its ligaments. The result may be continuous pain on sitting; and the bone is sometimes curved inwards, and causes obstruction and pain in defæcating. The condition of the parts is determined by passing the finger into the rectum and examining the bones between the finger and thumb. In persistent cases the bone should be removed through a curved incision with the convexity pointing away from the anus.

DISEASES OF THE SPINE.

Spina bifida is a congenital defect of the spinal canal, through which part of the cord or its membranes, distended with cerebro-spinal fluid, is protruded. It arises by arrest of development of the mesoblastic elements forming the posterior part of the spine, *i.e.* the verbal arches and muscles; sometimes also of the cord; and occasionally of the skin as well, so that an opening (*rhachischisis*) is left. The skin and spinal dura are usually intimately united, as differentiation into layers has not proceeded; hence the covering of a spina bifida is often no more than a thin membrane. Three forms are described: (1) *spinal meningocele*, in which the sac is composed of spinal membranes, and the interior communicates with the subdural or more frequently the subarachnoid space; (2) *meningo-myelocele*, in which the spinal cord or nerves are lying free in the sac, or more commonly spread out over its walls; and (3) *syringo-myelocele*, in which the central canal is dilated, and the posterior part of the cord is blended with the sac wall, the interior therefore communicating directly with the internal channels of the cord and brain. Sometimes instead of a protrusion there is a small depression where the arches are deficient (*spina bifida occulta*), and the site is often covered with a tuft of hair. The deformity is generally situated in the middle line, in the lumbar, or less commonly in the dorsal or cervical regions. In exceptional cases it protrudes anteriorly through the bodies. It usually involves two or three vertebræ, and the tumour is generally single, though sometimes it is multiple. The condition is often associated with hydrocephalus.

Symptoms.—There is a swelling in the middle line in the situations mentioned; soft and fluctuating in consistence, but increased in tension with crying or straining, and covered usually with a thin translucent membrane. Pressure on the sac causes bulging of the fontanelles, and may set up convulsions; and deep palpation at the edges may reveal the defect of the vertebral arches. When the cord or nerves form part of the tumour there is often paralysis or deficient development of the lower limbs (club-foot, etc.).

Prognosis.—The great majority of cases are fatal within the first year, from rupture of the sac with loss of the cerebro-spinal fluid, or from myelitis, or paralytic defects. In general, the better is the prognosis, the smaller and more pedunculated the swelling, the thicker its walls, and the less the implication of nervous structures. If the child survives, there is always danger of pressure or rupture of the tumour, or of eczema leading to suppuration and infective myelitis. Occasionally the neck closes spontaneously and the swelling atrophies. Complete openings cause death in a few days from myelitis.

Treatment.—The swelling should be protected with a firm cover of leather or felt, and the skin tended carefully to prevent irritation. In favourable cases, where there is not much paralysis, the tumour should be excised. Two skin flaps are made, the sac is separated from the edges of the opening, and cut away after the neck is occluded by ligature or suture, and the skin wound closed. Any nerve fibres seen in the sac wall should be preserved; and if they cannot be separated, the whole sac may be invaginated into the canal. In order to make a firmer covering, flaps of muscle, fascia or bone may be turned over the gap, and an additional safeguard is obtained by making the skin incision transverse and the spinal incision vertical. The child is laid face downwards on a pillow with the head lowered during the operation, so that the cerebro-spinal fluid does not drain away; and it is nursed in the same position till the wound is healed. The injection of *Morton's fluid* (iodine, potassium iodide and glycerine), as a radical method of cure by causing inflammatory adhesions at the neck of the sac, is attended with so much danger and such uncertain results that it is no longer used.

Tubercular disease (*tubercular spondylitis; spinal caries; angular* or *Pott's curvature*) is the commonest disease of the spine, and one of the most frequent of diseases of bone. It is most prevalent between the ages of 5 and 15, but occurs also in adults. It is probably often excited by injury; but in children it is difficult to establish a direct relationship, as slight injuries are so common at that age.

Pathology.—The disease almost always attacks the bodies of the vertebræ, and later the intervertebral disks; while the joints and arches are seldom affected. The bony tissue becomes softened and disintegrated, and when pressure is applied by weight-bearing, the bodies are crushed together in front, and at the same time the spinous processes are separated by the action of the hinge-like articulation. If one vertebra only is destroyed, the kyphosis is acute (*angular curvature*), and the cord may be kinked; if several vertebræ are affected, as is usually the case, the deformity is a more gradual curve, and in slight cases may even escape detection. The surrounding parts are more or less hyperæmic, and inflammatory thickening in the spinal canal or intervertebral foramina may cause pressure on the cord or spinal nerves; in children this hyperæmia is often evidenced in the skin by abnormal growth of hair along the spine.

The disintegrated bone usually forms a *cold abscess*, which generally strips up the anterior common ligament and makes its way, aided by gravitation and guided by the fascial planes, to various points near the surface; or the pus may dry up. Sometimes a large sequestrum is formed, which takes long to break up; or it may be absorbed without pus-formation (*caries sicca*). In disease of the upper cervical region the pus appears as a *post-pharyngeal abscess*, or at the side of the neck usually behind the sterno-mastoid. In that of the lower cervical region it may penetrate to the posterior mediastinum, and discharge into the œsophagus or air passages. In the dorsal region it may follow the line of an intercostal artery to the pleura, or point externally; or pass down with the aorta through the diaphragm, and follow the external iliac artery to point in the groin (*iliac abscess*), or extend downwards in the thigh; less often it follows the internal iliac, and passing through the sciatic notch presents as a *gluteal abscess*, or even appears in the *ischio-rectal* fossa. In the lumbar region the pus usually ruptures into the sheath of the psoas muscle, and follows its course to present at the inner side of the femoral artery as a *psoas abscess*, where it may cause rigidity of the hip by its tension in the muscle; or it may spread to the popliteal space and other parts of the thigh; or to the hip-joint by way of the psoas bursa. Sometimes the pus appears near the surface as *paranephritic*, *lumbar*, or *sacral* abscesses; and in rarer instances it may follow the vertebral canal, and exert pressure from its bulk, or set up pachymeningitis.

Symptoms.—Rigidity of the back, from reflex muscular contraction to prevent injury, and in the late stages from fibrous or bony ankylosis. Local tenderness elicited by pressing over all the spinous processes one by one, or by tapping or pressing gently on the head so as to exert a crushing stress. Pain on movement: to avert this in disease of the cervical region, the child holds his head in both hands; and in that of the dorsi-lumbar region, if asked to pick up an article from the floor, he supports the body with the hand on the knee and lowers it by bending the legs while the spine is kept stiff and vertical. All movements are made with caution, and the child holds on to any piece of furniture handy, to protect the spine against sudden jars. In the early stages, the disease should be suspected when a child easily tires of his play and often lies down to rest himself.

Deformity may be so slight that it passes unnoticed even when a large abscess has formed; in other cases it is well marked. Curvature is nearly always antero-posterior, lateral bending being rare. When the spine is bent at one level, a compensatory curve is often developed at another level. In the cervical region, the neck may be bent so that the chin rests on the sternum. In kyphosis of the upper dorsal region the ribs are inclined downwards and approximated to the spine, so that the chest is flat and shallow. With kyphosis in the lumbar region and compensatory lordosis in the dorsal, the ribs are raised and the thorax is short and narrow, and projects forwards (*pigeon-breast*). The body is shortened, the arms appear abnormally long, and the head is sunk between the shoulders. These deformities cause displacements of the thoracic and abdominal organs, and disarrangements of the attached muscles.

Painless abscesses may appear in any of the parts mentioned above; they are filled with tubercular debris, or in very chronic cases with an almost clear fluid; the walls have usually a well-developed "pyogenic membrane" covered with a thick layer of fibrin.

Pressure on the cord from inflammatory thickening (pachymeningitis, periostitis, or cold abscess), or from kinking of the spine, gives rise to partial paralysis of the lower limbs. Sensation is generally not lost, as the pressure is confined to the anterior (motor) parts of the cord; but there is sometimes numbness or tingling of the legs. Pains along the intercostals (*pleurodynia*), encircling the body (*girdle pains*), or referred to the front of the abdomen and complained of as *stomach-ache*, are probably due to irritation of the spinal nerves as they emerge from the canal.

Diagnosis from other conditions is seldom difficult. In the early stages the pain may be simulated by *rheumatism* and *lumbago*, which generally yield to suitable treatment. Rigidity and curvature may be occasioned by *osteo-arthritis*, which is usually evinced by signs of it in other bones; by *rickets*, in which the curve is more rounded and disappears more readily on gentle extension; or by *lateral curvature*, in which the deformity is usually quite different. Erosion of the vertebræ may be caused by malignant *tumours* which usually give rise to extreme pain; and *aneurysms*, which may be detected by auscultation; also by *syphilis* and hydatid *cysts*. Paraplegia may arise from *infantile paralysis*, in which the onset is more sudden, and atrophy is more pronounced. Most of these conditions may be imitated in *hysteria*, but the symptoms are not constant, the signs of caries are absent, and other evidences of hysteria may be detected.

Cold abscesses in connection with caries may also give rise to difficulty in diagnosis. Chronic post-pharyngeal abscess should be distinguished from *acute abscess* in this locality by the history of acute inflammation (sometimes a very uncertain matter); and from solid *tumours* by their consistence. Lumbar abscess, from *perinephritic* abscess by the history of irritation of the kidney, etc. Iliac abscess, from that following *appendicitis* by the absence of a previous acute attack and by other symptoms, and from *aneurysm* of the iliac artery, in which there is bruit and expansile pulsation. Psoas abscess, from *hernia*, which is reducible with a slip and gurgle: from *bubo*, in which the onset is rapid and the pain acute at first; from *tumours* by their consistence; and from *hip-joint disease* by the absence of pain in the joint and the freer mobility of the limb.

Prognosis is fairly good in children, but becomes less so as age increases. Recovery takes place with subsidence of bone-destruction and abscess-formation, and ankylosis of the spine. If the case is seen sufficiently early, kyphosis ought not to appear; and it is part of the treatment to encourage ankylosis in a proper position. In all cases progress is slow; several years being sometimes required to effect a cure. The causes of death in unfavourable cases are: (1) septic infection of a cold abscess or carious bone, followed by hectic fever; (2) acute inflammation or sudden rupture of the cord; (3) hæmorrhage from a large vessel involved in an abscess; or (4) suffocation from rupture of an abscess into the lungs or air passages.

Treatment.—Besides the ordinary constitutional treatment of all tubercular cases, the chief requirement is rest to the spine. As soon as diagnosis is made, the patient should be laid on a flat bed on his back, with padding under all bony prominences. If the deformity does not sensibly diminish with this position, extension may be applied to aid straightening; and this should be used in any case where there is spastic twitching of the legs. (*Calot's* method of forcible straightening of the spine under anæsthesia is properly abandoned on account of its danger and inefficiency.) Children may be fixed in double splints of *Bryant's*, *Hamilton's* or *Thomas's* patterns, or in *Phelps's* box, which is a wooden casing lined with padding into which the child is strapped, or in a somewhat similar case of plaster-of-Paris applied to the back of the body and legs: these enable the patient to be carried out into the open air in fine weather. Rest in bed is continued until pain and other acute conditions have abated; when the body should be encased in a plaster jacket (*Sayre*), applied while the patient is slung up by the neck and shoulders, so that the spine is straightened out as much as possible short of causing pain, or injury to the spinal structures. The plaster jacket must rest on the pelvis and grip the chest high up so as to maintain the improved position; if there is a projecting spine, it must be guarded against pressure by cutting a hole in the plaster or making a cup-shaped depression lined with wool into which it fits. The patient should be sent to the sea-side if possible, and be encouraged to take exercise in the open air short of fatigue. If pain recommences, the patient must again be confined to bed. The plaster requires renewal as often as it becomes loose or foul; and occasion should be taken at each change to attempt gentle straightening of the spine. When all active disease has subsided, the plaster should be exchanged for an adjustable corset: this may be a poroplastic jacket, or well-fitting steel-ribbed stays.

When the disease is in the cervical or occipital region, the head must be supported by slings from a *jury-mast* fixed to the jacket, or by an extension of the plaster or poroplastic, to form a neck support and cap (*Walsham*), to which the head is bandaged; or a stiff collar of poroplastic or leather may be worn, so that the occiput and chin rest upon it, while the collar rests on the shoulders; a pneumatic collar (*Fleming*), or wire spring collar (*Moore*) acting on the same parts are rather more comfortable.

Psoas and other abscesses should be evacuated as soon as possible. For small ones a trocar may be passed obliquely through the tissues so as to make a long valve-like opening, but, in order to prevent microbes being carried inwards from the depths of the skin, a small cutaneous incision should first be made with a knife. After evacuation, the cavity may be injected with iodoform emulsion in glycerine or oil. Larger abscesses are better opened by a free incision, and flushed out with sterile saline solution, to get rid of the débris and fibrinous lining. The interior may be also scraped with a flushing spoon (*Barker*), the lotion being sufficiently hot (105° F.) to check bleeding; but damage is apt to be done in this way to delicate structures in the walls of the abscess: and as the spoon can seldom reach the diseased bone, probably as good results are obtained by wiping out the cavity with gauze, or by plain flushing. Three or four ounces of iodoform emulsion are injected, and in all these cases the wound is closed and sealed. The cavity usually fills up again to some extent; and, if the fluid is not soon reabsorbed, it should be removed as before. Each succeeding operation shows the fluid to be clearer and less in quantity; and finally no more is formed. In the most favourable cases the abscess cavity becomes replaced by cicatricial connective tissue. In some cases a psoas abscess may also be opened near its origin; and this gives the opportunity of removing necrosed bone if present. Retro-pharyngeal abscesses should be opened from the neck; and lumbar abscess at the nearest point. All these operations must be carried out with scrupulous asepsis; and should any abscess become septic, it must be drained, or, much more safely, laid freely open and packed with iodoform gauze like any other open septic wound.

Pressure on the cord, as indicated by spasm or paralysis of the muscles, may sometimes be relieved by laminectomy: this is most successful when the curvature is very sharp. In other cases, when the curvature is not acute, pressure is not relieved in this way; but the inflammatory thickening in front of the cord, which is the most frequent cause, may be reached through a wound involving the transverse processes and heads of the ribs, and can sometimes then be removed with a curette (*Ménard*).

Occipito-atloid and **Atlanto-axial** disease are special forms of tubercular spinal disease, in which more particularly the articular surfaces of these joints are implicated; though the inflammation may start in the bone, as in lesions of other joints. The ligaments may become loosened, and the head has then a tendency to be displaced forwards; if the odontoid process of the atlas is diseased, a sudden jar may fracture it, dislocate the head, and cause instant death.

The chief **symptom** is severe pain shooting up the back of the head or down the neck; this is increased by any movement, and the patient generally holds the head in both hands to keep it steady; the head cannot be rotated without pain, and so has to turn with the body. An abscess may develop in the neck, or in the post-pharyngeal tissue.

Treatment consists in laying the patient in bed with sand pillows at the sides of the head; replacing these as soon as possible with a plaster or poroplastic case to the back of the shoulders and head, and when the symptoms subside, with a jury-mast or neck-collar. The extreme pain is often relieved by the actual cautery applied to the neck, and this appears to help the cure of the disease.

Syphilis, Acute Osteomyelitis, and **Actinomycosis** are all rare; but they, especially the last named, may give rise to symptoms similar to those of tubercular caries or of tumours.

Osteo-arthritis (*spondylitis deformans*) is a disease of middle and late life, which is characterised amongst other symptoms by osteophytic inflammation of the vertebræ; disappearance of the intervertebral disks; and ankylosis of a number of the vertebræ and often of the whole spine in one bony mass; with outgrowths along the line of the common ligaments. Later on, the lateral and spinous processes and the spinal ends of the ribs also become joined together, and all mobility of the thorax becomes lost. The symptoms are severe pain, and arching of the spine; and when ankylosis of the ribs is established, difficulty of breathing, or disease of the lungs (*see* also p. 216).

Tumours of the *vertebral column* are rare, except metastatic growths secondary to malignant tumours arising elsewhere in the body. They give rise to severe boring pain, and, according to their situation and extent, to irritation or destruction of the cord. Congenital tumours are met with in the sacrococcygeal region (page 69).

Primary tumours of the *cord* or its membranes are not common; but fibrous or other growths may be met with. They may be diagnosed and located by their effects on the various tracts and levels of the cord. In suitable cases the spinal canal may be opened by laminectomy, and the tumour possibly removed.

Scoliosis (*lateral curvature*) is a deformity in which the spine is deflected to one side, usually the right, in the upper dorsal region, with a compensatory curve of the lumbar region in the opposite direction, and accompanied by rotation of the vertebræ. It occurs most commonly in girls, especially those of an anæmic type, and appears about the age of greatest growth; *i.e.* from the tenth to the eighteenth year.

Ætiology.—It is due in the first instance to *weakness* of the muscles of the back, arising from illness, rapid growth of the skeleton at the expense of the muscular system, unsuitable feeding, bad hygiene, or possibly hereditary tendencies. The local causes are habitual *over-fatigue*; *faulty positions*, such as in carrying weights persistently in one hand, and distorting attitudes in writing at school; or *compensatory curves* from torticollis, or from tilting of the pelvis from standing on one leg, hip disease, unequal length of legs, genu valgum or flat foot. It also arises *directly* by contraction after burns or empyemas.

Pathology.—As the muscles relax, support of the spine falls on the ligaments, which soon become stretched, and allow the spine to bend. This distortion, acting on the incompletely ossified vertebræ, crushes them together at the concavity of both curves, until they assume a wedge shape. In order to adapt themselves more easily to the bent position, the vertebræ always rotate to some extent in the vertical plane, the spinous processes pointing towards the concave side. The ribs of course follow the vertebræ, and gradually become distorted, those on the convex side being acutely bent about the angle, and those of the opposite side being straightened out and crowded together; so that the chest assumes a rhomboid shape and is generally diminished in capacity. The projection of the angle of the ribs carries the scapula with it, causing it to project; indeed it is for "growing out of the shoulder-blade" that the patient is usually brought to the surgeon; though sometimes the projection of the hip is more prominent.

Symptoms.—The patient should be stripped to the waist and made to stand in front of the surgeon. At once the right (or sometimes the left) shoulder is seen to stick out, and the opposite hip is prominent. The body is now bent forwards as far as possible with the hands hanging down, in order to show how much of the curve disappears with this position. The spinous processes should be marked with a skin pencil, and the line compared with that produced when the patient assumes the upright position. She is then directed to bend the body to either side and rotate it, and hang by the arms from a cross-bar, so that the spine straightens out. By these means the extent of the deformity and the range of movements can be determined. For the purpose of comparing progress, a scoliosometer (*Mikulicz*) should be employed: it consists of two graduated rods sliding on one another at right angles, with or without a protractor to indicate the angle between the line of the spinous processes and that joining the iliac crests. By means of this device the displacements from the middle line may be noted at different levels.

Prognosis. — If seen early enough, the disease is very amenable to treatment; the degree of curability varying with the absence of deformity of bones and ligaments.

Treatment consists essentially in improving the muscular tone, and reducing the deformity. The former is achieved by general constitutional means; and by graduated exercises of the muscles opposing the deformity, such as lifting weights, pulling on elastic cords, and swinging and rotatory movements of the body, etc. The deformities are counteracted by lying on a flat board for one or two hours a day, and hanging by the arms, etc., while inequalities of the legs and other defects must be remedied by wearing pattens or thick soles, etc. All exercises must be carried out regularly, with intervals of rest, in short periods which may be increased from week to week; if carried to the point of fatigue, they are usually worse than useless. Only when the deformity is so great that it causes pain from pressure, or interferes with function, should a mechanical support be worn; and then it should be removed at intervals to allow of movements and exercises.

Kyphosis is forward bending of the spine. Besides occurring very prominently in caries of the spine, it arises from habitual stooping over various occupations, and it is encouraged or confirmed by weakness of the back. It also occurs as a frequent deformity in osteo-arthritis, hypertrophic osteo-arthropathy and in rickets.

Lordosis is an exaggeration of the normal lumbar curvature; and the shoulders are compelled to be thrown back to maintain balance. It is seen most frequently in cases of fixation of the hip-joint from disease, and is developed to allow the lower limb to be brought into line with the other in the extended position. It arises sometimes from muscular atrophy of various origins.

Spondylo-listhesis is a chronic subluxation forwards of the lowest lumbar vertebra on the sacrum. It occurs usually from injuries, but sometimes as a result of weakening of the ligaments, with displacement from weight-bearing.

CHAPTER III.

FACE, EAR, NOSE AND MOUTH.

INJURIES AND DISEASES OF THE FACE.

Contusions of the face in the region of the orbit are familiar to all as "black eyes." The discoloration due to extravasation of blood is not amenable to any treatment but time; but it may be prevented to some extent by the application of firm pressure and cold immediately after the injury, to control the bleeding.

Wounds of the face bleed profusely, owing to the very free blood-supply; for the same reason they heal very rapidly. Plastic operations, therefore, do specially well on the face.

Fractures of the **upper jaw**, the **malar bone**, or the **zygoma**, are usually the result of extreme violence. The displacements are so varied that no rule can be given for their reduction. The maxillary antrum may be opened in fractures of the superior maxilla.

Treatment.—The bone must be returned as nearly as possible to its proper place, and this often entails making a small wound to insert an elevator below it.

Rodent ulcer (*vide* p. 66) occurs usually on the upper part of the cheek near the inner or outer canthus of the eye, or at the edge of the nose. It is of slow growth, and the glands are rarely affected. It should be treated with X-rays, as the results are sometimes remarkably successful. If improvement does not take place the ulcer should be excised, and the defect closed by a plastic operation.

Parotitis occurs primarily in the epidemic form of mumps, which rarely requires surgical treatment. It is, however, sometimes accompanied by inflammation of the testis, and if suppuration takes place, an incision should be made there as soon as possible to prevent atrophy. The ovaries, mamma, and other glands may be similarly affected with "metastatic" inflammation. Parotitis also occurs *secondarily* in the course of acute specific fevers, especially enteric. An important variety of secondary parotitis, affecting both glands, or more usually one, is that which follows abdominal and sometimes other operations. The pathology of *post-operative parotitis* is not yet clearly known, but it is obvious that infection spreads from the mouth by way of Stenson's duct, when the gland is not in a state to resist invasion. This want of immunity has been attributed to abeyance of function due to starvation methods of treatment; to general inertia of the bowels, with accumulation of waste products in the blood; and to reflex influence of some kind from the abdominal organs. None of those conditions alone are sufficient to explain the occurrence of parotitis. The presence of dryness of the mouth, collection of sordes, or obvious oral sepsis, favours its occurrence. The *symptoms* are rise of temperature and general febrile conditions; pain and swelling and sometimes œdema in the region of the gland. Fluctuation may be felt when pus has formed; but, owing to the dense capsule, it is very often impossible to detect. In favourable cases the inflammation subsides in two or three days; but in suppurative cases the pus may burrow and discharge into the external auditory meatus, or into the deep cellular planes of the neck, and invade the mediastinum.

Treatment.—The *prophylactic* treatment consists in cleansing the mouth with gauze and moistening it with glycerine and borax, and commencing ordinary diet as soon as the digestive state of the patient allows of it. When inflammation occurs, for the first few days warm fomentations may be applied to soothe the pain, or iodine may be painted on as a mild counter-irritant. If the inflammation does not subside after three days, an incision should be made on the probability that pus may have formed; if pus is not found, tension will at all events be relieved, and the wound will soon heal with little mark. The incision should be made horizontally in order to avoid the branches of the facial nerve. The skin and fascia must be divided with a knife, but the opening should be continued by Hilton's method; and a drainage-tube should be inserted, as the opening is apt to close up.

Parotid abscess occurs in the foregoing; but also from infection and suppuration in the *lymphatic* tissue which is found embedded in the salivary gland near its posterior border. This may become implicated by disease of the salivary gland, or by spread of infection from the face, or indirectly, from the submaxillary gland. It must be treated in the same way as the preceding.

Chronic parotitis is due to tuberculosis, or to chronic irritation from calculi, which cause intermittent swelling and pain, or from other obstructions to the duct. If obstruction is complete a cyst may form; and if this bursts through the skin a salivary fistula results.

Salivary fistula is due to a wound of Stenson's duct or of the salivary gland. It arises also from ulceration due to disease or to a calculus, accompanied by obstruction to the duct. There is a small opening on the cheek which discharges saliva, especially during eating.

Treatment.—Wounds of the gland heal readily if the discharge has free passage to the mouth. If there is any obstruction a small bougie should be passed into the duct from time to time. When the opening is in direct communication with the duct, a director should be passed through it and forced into the mouth. The walls of the fistula are then excised with a narrow knife, and the small wound closed with a stitch. The opening into the mouth may be kept free by passing a silver stitch through the edge of the orifice. All attempts at closure before active ulceration has ceased are usually in vain.

EAR.

Injuries heal readily, and **wounds** unite quickly if sutured, owing to the free blood-supply. This also favours the formation of *hæmatoma auris* following slight bruises; and the resulting cicatrisation sometimes leads to deformities of the ears. This condition is said to be specially common in the insane.

Foreign bodies, or masses of impacted cerumen, should always be extracted with the aid of the ear mirror and speculum; if this is done, the risk of damage to the membrane during their removal is slight. In ordinary circumstances most foreign bodies can be removed by briskly syringing out the meatus with warm water. If the body, such as a pea, is likely to swell by imbibition of moisture, it may be shrunk with a few drops of alcohol instilled into the meatus.

Boils in the meatus are extremely painful, and should be incised as soon as possible. The meatus is dried out from time to time, but not packed; and a small absorbent dressing applied to the ear.

Ivory exostoses may give rise to pain, or interference with hearing, or encourage collection of cerumen in the inner part of the meatus. They are removed most conveniently by a small burr.

Acute catarrh of the middle ear is a common accompaniment of severe coryza and the acute infectious diseases; or may follow direct irritation with cold water in bathing, or by nasal douching. It commences fairly suddenly, with pain in the ear of a stabbing or throbbing character, and at first intermittent. In the milder form there is little effusion; and the pain, which is due mainly to swelling of the mucous membrane and blockage of the Eustachian tube, may be relieved by application of hot cotton wool over the side of the head, or by syringing the ear with warm boracic lotion which is afterwards dried out. If the pain is very acute, injections of ether vapour through a Eustachian catheter sometimes give relief. In the more severe form the exudation is muco-purulent, and the symptoms are accordingly aggravated, and may even give the signs characteristic of meningitis (*vide* p. 261). On examination the membrane is seen to be distended with opaque yellow fluid. If spontaneous rupture of the membrane does not take place soon after the pus makes its appearance, and in all cases where the temperature remains high or rigors occur, the membrane should be punctured (*paracentesis*) with a narrow knife. As this operation, though momentary, is extremely painful, the patient's hands should be controlled, and the head placed against an immovable surface. In children a whiff of chloroform should be given; in adults the membrane may be anæsthetised to some extent by instilling into the meatus three drops (maximum) of a 25 per cent solution of cocaine in aniline oil (*Gray*). After puncture, the ear should be lightly filled with iodoform gauze, and this changed as often as it becomes wet. If the discharge is thick the ear may be *gently* syringed with boracic lotion. Inflation should be practised in all cases, at least until the discharge has ceased. The incision is apt to close very rapidly, and may require to be repeated. For *chronic suppuration* see a work on the Ear.

Mastoiditis.—Inflammation of the mastoid is generally secondary to disease of the middle ear, from which it spreads by way of the attic and antrum. Other cases, however, seem to be set up primarily (especially in diabetes) by infection through the circulation. It occurs as catarrh or suppuration of the mastoid cells, or as osteomyelitis of the intermediate bony walls; but usually those are combined. If it is dependent on an attack of acute otitis, the mastoid disease is mild in character, and usually subsides if the middle ear is relieved of its effusion. When secondary to a chronic ear condition it is generally severe, and may be very acute; if unrelieved by operations it rarely subsides, and its terminations depend on the comparative resistance of the adjacent tissues. It often spreads outwards, and sets up first periostitis, and then subperiosteal abscess, especially in children. If it spreads inwards, it may cause thrombo-phlebitis of the lateral and sigmoid sinus; or it may penetrate to the base of the skull and set up meningitis, or abscess in the brain or cerebellum.

Symptoms.—There is swelling and œdema over the mastoid process, and if abscess develops the ear is pushed forwards and outwards. There is boring pain referred to the ear or the temporal bone, usually intermittent, and there is great tenderness on pressure. Fever of a remittent type, and other inflammatory signs accompany these symptoms, and vary in intensity according to the severity of the disease.

Diagnosis.—From acute otitis with œdema of the mastoid, by the tendency for the swelling to extend rather than remain limited; from external inflammation of the ear, with œdema of the soft parts, by the presence of signs of old middle ear disease, and absence of a source of external irritation.

Prognosis.—Mild mastoiditis associated with acute otitis may subside with antiphlogistic treatment. The other forms are dangerous, and should be treated surgically without delay.

Treatment.—In the *catarrhal* forms, Leiter's tubes or cooling lotions should be applied to the back of the ear, and the tympanic membrane if still intact should be incised to give exit to the discharge, in order to relieve tension and prevent further absorption. In the *suppurative* forms, it is sometimes sufficient in children (where the mastoid cells as a rule are few in number, and only slightly developed, and the disease is often of a periostitic nature) to make a perpendicular incision down to the bone at the back of the attachment of the auricle. If any pus is seen exuding from the surface, the bone should be opened up a little. In adults the mastoid must be fully exposed, and, if necessary, a horizontal incision made backwards from the first. The diseased interior is scooped out with a sharp spoon, gouge, or burr, until a smooth wall of healthy bone is left (see *sinus thrombosis*). The membranous meatus is separated from its bony wall behind, the posterior half cut across and retracted forwards, and the middle ear cleared out. The cavities of the mastoid and ear are united by removing the bridge formed by the posterior wall of the bony meatus, and the whole cavity is packed firmly with iodoform gauze. The wound behind the ear may be left open and allowed to heal by granulations; or a plastic operation may be done to cover the hollow with epithelium. For this purpose a horizontal incision is made into the membranous meatus, and extended into the concha and there curved upwards, so that a flap is formed (*Stacke*). The cartilage is removed, and the flap is turned into the wound so as to lie on one of the walls of the cavity, and is kept in contact by firm packing through the enlarged meatal orifice. The posterior wound may be sewn up, and the cavity dressed from the ear. After granulations have been established, the part uncovered with flap may be grafted with Thiersch's grafts (*Ballance*). This may be done from the meatus, or more easily by opening up the posterior wound temporarily for the purpose.

NOSE.

Acne rosacea, a dilatation of the capillaries with hypertrophy of the skin of the nose, occurs in elderly people, most commonly in females. It is ascribed to alcoholic excesses and exposure to cold, but it is sometimes due only to disorders of the sexual or digestive functions. If it is refractory to stimulating ointments the surface should be scarified, in order to promote subsequent cicatrisation.

Rhinophyma ("*Lipoma*" *nasi*, "*grog blossom*") is a hypertrophy of the subcutaneous and sebaceous tissue of the nose. It, too, occurs in elderly persons exposed to bad weather; and more justly is ascribed to the effects of habitual alcoholic excesses. The nose becomes bulbous or even pendulous, and purple or red in colour. The most suitable treatment is to shave off the superabundant tissue, taking care not to cut through the cartilage, and allow it to heal by granulation, aided if necessary by Thiersch's grafts.

Lupus vulgaris occurs most frequently at the junction of the nose and cheek, and is commonest in early life. It begins as a dusky coloration of the skin, in which may be seen minute specks of "apple jelly" appearance—the tubercles. These tend to coalesce and break down, and give rise to irregular areas of ulceration, granulation, and scabbing: (cf. *lupus erythematosus*, in which ulceration does not take place). The disease spreads along the cheeks and the surface of the nose, and may destroy a large extent of the alæ; but it may invade the mucous membrane, and pass to the palate and fauces. If cicatrisation takes place, it may result in considerable contraction of the nasal orifices.

Treatment.—In the earliest stages the small area should be excised completely. If seen too late to do so without leaving a large defect, it should be scraped with a fine sharp spoon until all the soft tissue is removed, after which the surface may be cauterised with pure carbolic. This process should be repeated at intervals of two or three weeks, according as cicatrisation proceeds, all the healing skin being left, while the unhealthy granulating part is persistently curetted. In wide-spread lupus Finsen light may be tried, in order that the cicatricial deformity may not be so marked if the treatment is successful. In some cases otherwise refractory, tuberculin (R) has a beneficial effect, but its dangers must not be ignored. With any treatment, however, recurrences are not uncommon.

Syphilitic ulceration in the later stages may readily be mistaken for lupus; but it usually occurs later in life, it is more rapid in progress, the edges of the ulcer are clean-cut rather than ragged, there are often other signs of syphilis in the body, and the disease generally reacts to antisyphilitic remedies. There may be considerable destruction of the septum or soft palate, and deformities of other parts. The condition of "saddle-nose," due to destruction of the nasal bones, may be improved by injecting warm paraffin (melting point 106°-110°) into the cellular tissue. In doing so, care must be taken to make firm pressure on each side of the nose, otherwise the paraffin may find its way into the cheeks or eyelids.

Defects of the nose are due to injury or disease, especially to syphilis and tuberculosis. Slight defects of the ala may be repaired (*rhinoplasty*) by cutting a flap from the adjacent cheek with the base near the nostril, and twisting it inwards to the nose, where it is sutured to the freshened edge. The *Indian* method is the most suitable for extensive destruction. A flap is taken from the forehead, with a pedicle left near the eyelid enclosing the frontal vessels for its nourishment while union is taking place. It is usually made triangular in shape with a stalk at the extremity to form a septum, but a pattern should be previously made, to which it must conform. The edges of the defect are freshened, and the flap is turned downwards and sutured in position. After union has taken place the pedicle may be trimmed into shape or excised. If there is enough tissue available, an internal lining of epithelium should be made in order to prevent excessive contraction of the new nostrils. This is done by turning down a flap from the bridge of the nose (*Keegan*), or inwards from the cheek, and suturing the forehead flap over the raw surface. Healing of the forehead wound may be hastened by inserting a few sutures to diminish the size of the bare surface, and so make the scar less unsightly; this is aided by making a few long incisions in the hairy scalp, where the scars will not be seen afterwards. If the nasal bones are widely destroyed, support for the flap may be got by including a scale of bone from the forehead with it; this may be cut off with a broad chisel, (*König*). Silver or vulcanite tubes may be worn in the nose for the same purpose. The *Tagliacotian* method consists in cutting a flap from the arm, leaving a wide pedicle, and suturing the flap to the nose. The arm is bound firmly to the head until the edges unite, when the flap is finally cut loose from the arm.

Bleeding from the nose (*epistaxis*) is very common. It arises from a variety of causes, (*a*) a blow on the nose, fracture of the nasal bones or septum, fracture of base of the skull, or injury by foreign bodies in the nares; (*b*) ulceration due to disease, especially tubercle and syphilis, or to new growths; (*c*) congestions of the mucous membrane, due to vascular tension, dependent on disease of the heart or vessels, the liver or kidneys, and on acute fevers, or purpura, and in some cases of vicarious menstruation. It also occurs spontaneously in children about the age of puberty. The commonest point of hæmorrhage,—the *seat of election*,—is on the septum, just inside the orifice.

Diagnosis.—The source and cause of epistaxis should be ascertained if possible, as bleeding in some cases of congestion is of benefit in relieving tension, and should not be checked.

Treatment.—In slight cases the application of a cold sponge to the back of the neck and sniffing up ice-cold water are sufficient to stop it. The patient should be kept sitting up, and not allowed to bend the head over a basin and so add to the congestion in the head. In obstinate cases a solution of adrenalin (1–10,000) in cold water may be sniffed up, or injected into the nostrils, or (1–1000) applied on a pledget of cotton wool. If bleeding recurs the source should be sought for, and the bleeding point touched with a cautery. Sometimes when bleeding persists, especially after an operation on the nose, it is necessary to pack the nasal cavities firmly with iodoform gauze, after cocainising the mucous membrane if bleeding allows of it. If a rubber-bag tampon is available, it may be lubricated and passed into the nares with a long forceps, and then distended. If the *posterior nares* require to be plugged, few instruments (not even Bellocq's sound) are more useful than a soft rubber catheter. It is threaded with a long piece of stout silk by means of a needle, and passed along the floor of the nose until it presents in the naso-pharynx. Here the silk can be caught with a forceps, and the loop pulled out at the mouth. The catheter is withdrawn, and the silk is left hanging out of the nose and mouth. A small roll of iodoform gauze is now attached to the silk and drawn up into the naso-pharynx where it becomes jammed, being guided round the soft palate by the finger. A similar plug is passed into the nostril, and the ends of the silk tied firmly over it. The plugs should be removed at the end of forty-eight hours, and fresh ones inserted if necessary.

Foreign bodies, if allowed to remain in the nose, will set up irritation, with persistent purulent discharge, and may cause necrosis of the bones; or deposit of lime salts may form round them—*rhinoliths*. They are of all kinds, and find their way into the nose, chiefly in children or lunatics, by being pushed in, or into the posterior nares by being vomited up. Persistent unilateral purulent discharge in a child is always suspicious, and, as a history of the entrance of a foreign body is rarely forthcoming, a complete examination of the nose should be made in these cases.

Treatment.—To remove the offending body the nostrils should be well dilated and illuminated; and in children an anæsthetic is generally advisable. The body should be caught in a long forceps or scoop, and withdrawn. If it cannot be pulled out, it may be pushed forwards by the finger passed into the posterior nares; or backwards into the naso-pharynx, where it must be caught and prevented from falling into the air passages. Occasionally lumbricoid worms are present in the nose; these should be killed with chloroform vapour and removed by douching, or in one process by using a *weak* corrosive sublimate douche.

Fracture of the nasal bones is not uncommon in children. All cases of suspected fracture should be carefully examined, as early reposition of the fragments is essential if deformity is to be prevented. The bones may be manipulated into place by the fingers, or with the blades of a dressing forceps. If the septum is broken, it must be straightened out in order to raise the bridge. The interior should be packed with iodoform gauze, which is more adaptable and less irritating than internal solid splints. An external splint, however, of lead or poroplastic is sometimes of advantage when there is difficulty in retaining the fragments in position.

Suppuration of the accessory sinuses of the nose has sometimes to be treated by the general surgeon. The **frontal sinus** may become infected through extension of disease from the nose, or from a compound fracture involving the sinus. The cavity communicates with the nose on either side through a narrow passage (*infundibulum*) which opens below the middle turbinated bone; and this may become blocked by polypi or swelling of the mucous membrane. If there is an excess of mucoid discharge it becomes pent up, and gives rise to signs of pressure—pain and other local effects; and if purulent (*empyema*), to those of septic absorption also.

Symptoms.—There is headache and pain along the supraorbital nerve, and a sense of fulness in the frontal region, and there is generally tenderness on pressure; there may be redness and œdema; and occasionally there are disturbances of the eye mechanism. There is usually some discharge of pus from the nose, especially on assuming the upright position; but as the other sinuses are often involved also, it is sometimes difficult to determine the source. If a probe is passed into the opening, a gush of pus may follow, and with it the pain and discomfort may abate for a time.

Treatment.—The nasal condition should be treated by removing the polypi, which are usually present and help to keep up the disease; and if necessary the anterior part of the middle turbinated bone must be cut away to give freer access to the orifice. This also allows of drainage and daily irrigation by means of a narrow bent canula. If improvement does not follow, a more radical treatment should be undertaken. An incision is made down to the bone through the eyebrow, which is shaved for the purpose. The edge of the wound is retracted upwards, and a trephine opening is made into the cavity. The whole lining is thoroughly curetted away, part of the anterior ethmoidal cells are removed if diseased, and a wide communication made into the nasal cavity. The hollow is filled with iodoform gauze, and a strip is passed into the nose to maintain the orifice for drainage. The packing should be removed gradually, and the edges of the wound eventually allowed to heal; meantime the cavity becomes lined with granulation tissue.

Empyema of the maxillary antrum (*antrum of Highmore*) is more common than that of the other sinuses. It arises by an extension of rhinitis, or from periostitis of the jaw due to a carious tooth. The pus accumulates in the antrum until the level of the natural opening is reached, and if there is no blocking by swelling or polypi it overflows into the middle meatus.

The **symptoms** are headache and neuralgic pains of the superior maxillary nerve, and sometimes œdematous swelling of the cheek, and a persistent discharge of pus with an unpleasant odour from the nose. By bending the head forwards and to the opposite side, the pus may be seen in considerable quantities, and traced to its source if the nose is previously cleansed. This helps to distinguish it from discharge from the frontal sinus. In the absence of a discharge of this kind, pus may be detected by aspirating with an exploring needle which pierces the thin bony wall of the inferior meatus, or with a bent hollow needle passed through the wall of the middle meatus where it is only membranous. If pus does not flow at once, it may be discovered by irrigating the cavity, when the outflow will be mixed with pus. Another method of detecting the presence of pus, or at least an opaque body, in the antrum, is by *transillumination*. A small electric lamp is placed in the mouth and the lips closed over it, and the face is examined in a dark room; the normal cheek and pupil show a dull red glow, while the pus in the affected antrum obscures the light and causes a dark shadow by comparison.

Treatment.—In some cases it is sufficient to irrigate the antrum through the natural opening or through a perforation made for diagnosis. If the discharge persists it is necessary to drain the cavity. Where a diseased tooth is apparently the origin of the disease it should be extracted, the socket enlarged and deepened, and a canula inserted into the antrum for drainage. In other cases it is better to make an opening through the canine fossa, and, after scraping out the lining membrane, to pack the cavity with a long strip of iodoform gauze. This should be changed first in two days, and diminished in quantity at each successive dressing; and care should be taken that it never slips entirely into the cavity. In more refractory cases a counter-opening of considerable size may have to be made in the nasal wall.

New-growths occasionally have to be removed from the nasal cavities. In the case of malignant tumours it may be necessary to perform a *temporary resection* of the nose. This may be done in various ways, (*a*) by retracting the lip upwards, incising the mucous membrane and separating the soft tissues subcutaneously off the jaw, cutting through the cartilages of the nose at the base with a pair of scissors, and turning the flap upwards (*Rouge*); (*b*) by making a horse-shoe incision round the sides and root of the nose, and cutting everything through except near the alæ, where it is turned down (*Ollier*); (*c*) or at one side only, and turning it to the opposite side (*Chassaignac*); (*d*) or splitting it down the middle, and separating the flaps (*Hippocrates*). It should be remembered that *every* intra-nasal operation is liable to be followed by sepsis, which may spread to the brain and set up fatal meningitis. In all cases, therefore, it is necessary to keep the nose as clean as possible, and free it from any decomposable matter, especially blood-clots. It is doubtful if antiseptic washes can have any beneficial effect proportionate to their irritative influence on the mucous membrane.

Polypi (masses of loose connective tissue containing mucin, or true myxomata) are very common in the nose, and are usually multiple; hence their removal must include the smaller ones which are apt to be overlooked, or recurrence of the trouble is likely to arise. They spring generally from the middle meatus at the edge of the middle turbinal or below it. They cause nasal obstruction and give rise to mouth-breathing, snoring, and "dead" voice; and any existing disturbance of the respiratory tract is apt to become exaggerated. The polypi are usually visible through the anterior nares like white glistening grapes; otherwise they may be detected by posterior rhinoscopy. Their consistence and the relation of their roots can be determined by means of a long probe.

Treatment.—After the mucous membrane is well anæsthetised with a 10 per cent solution of cocaine, the polypi may be seized with a long dressing forceps and twisted off one by one—care being taken to catch each one by its root and not to tear away part of the turbinal bone. A snare may be used instead, and for pedunculated polypi it is more satisfactory; but it is apt to slip over sessile growths. As the small ones, if left behind, continue to grow, and will eventually lead to a repetition of the symptoms, they must be removed as soon as they are large enough to be seized. To prevent further growth, the base from which they arise should be touched with a galvano-cautery, or with a bead of chromic acid fused on to a probe.

Fibrous polypi (*naso-pharyngeal fibromata*) grow usually from the periosteum of the base of the skull, and extend downwards and forwards into the nose. The base is sometimes broad and usually very vascular, hence the chief danger in removing them is from hæmorrhage. They should be removed with an electro-cautery snare. Sometimes they are *malignant* (fibro-sarcomata), and if the case is operable, a temporary resection of the nose is required to give access for their removal. The operation is severe, hæmorrhage is usually considerable, and recurrences are unfortunately frequent.

Adenoids.—Adenoid swellings of the tonsillar tissue (*of Luschka*) occupying the vault and sides of the naso-pharynx are very common in delicate children. Even in severe cases the tendency is towards gradual atrophy as age increases; but the bad effects of unnatural breathing may leave permanent traces. Adenoids are commonly associated with hypertrophy of the faucial tonsils.

Symptoms.—The back of the nose becomes obstructed, and the child always breathes through the mouth; and this gives rise to a vacant expression, with narrowing of the nose. The patient snores at night, and speaks as if he had a cold. The mouth becomes dry, the teeth decay early, and the general health suffers. The Eustachian tubes are often pressed upon or overlapped : and this causes deafness which makes the child slow at learning and apparently dull in intelligence. In addition, many physical and psychical deficiencies have been attributed to the presence of adenoids, some of them with very insufficient reason.

Diagnosis.—The characteristic facial appearance is generally obvious. The swellings can be distinguished by anterior and posterior rhinoscopy ; but they are often so uniform in thickness that they are difficult to distinguish by inspection. A much surer way of diagnosis of their presence and extent is to pass the finger into the back of the throat, where they can be felt as soft velvety folds.

Treatment.—In slight cases (where the patient can blow his nose) the treatment should be palliative and educative. The child should be taught to breathe through the nose habitually, and thus develop the nasal passages. If there is complete or frequent temporary obstruction the adenoids should be removed. The most reliable method is by some modification of *Gottstein's* ring knife, with a guard and catch to pick up the tumour after its excision. A general anæsthetic should be used,—bromide or chloride of ethyl, or nitrous oxide, being the most suitable. The mouth is kept open with a gag, and the knife is passed into the naso-pharynx, and, beginning immediately behind the septum, a firm sweep is made backwards and downwards close to the pharyngeal wall. The mass should come away in one piece, and if it remains attached the stalk should be torn away. For small adenoids, especially at the sides, *Löwenberg's* forceps are useful. The finger nail, natural or artificial, is a very inferior instrument for the purpose. If there is much narrowing of the nose it should be dilated at the same time. The *after-treatment* consists in keeping the child lying on his side till all bleeding ceases, so that the blood, which may collect in considerable quantities in the mouth, may flow out at the angle of the lips. No douching is usually necessary or advisable, as there is a danger of setting up ear disease. The patient is kept in bed for a couple of days, and in the house for a week more, when the surface should be healed.

Retro-pharyngeal Abscess.—The *acute* form arises from septic irritation from foreign bodies, extension of inflammatory processes after operations, and in the course of febrile diseases. The more common *chronic* form is due to formation of a "cold abscess" behind the pharynx and in front of the spinal column, arising from tubercular disease and disintegration of the upper vertebræ. The abscess presents as a rounded swelling at the back of the throat, and may press forwards so much that it obstructs respiration and swallowing. In the acute form there is high temperature, pain, and other signs of acute suppuration. In the chronic form there is little or no pain, but pressure on the head elicits pain in the neck, and there may be rigidity of the neck muscles.

Prognosis.—If these abscesses are left alone there is considerable danger of asphyxia from rupture into the larynx.

Diagnosis should be made carefully to distinguish the acute from the chronic; for, if chronic abscesses are opened through the mouth, they have little tendency to heal for a long time, and septic infection is almost sure to occur, with dire results on the patient's health or life.

Treatment.—The *acute* abscess may be opened by an incision in the back of the throat, under cocaine anæsthesia—the head being kept low and turned to the side to allow the immediate escape of pus and blood. The mouth and throat are kept clean with swabbing and spraying, and the wound soon heals. *Chronic* cases are treated differently. An incision is made behind the sterno-mastoid in the neck, and the opening enlarged by Hilton's method, and the cavity treated like tubercular disease elsewhere in the spine. In this way infection from the mouth is avoided.

MOUTH.

The lips are subject to many slight ailments,—*herpes*, in the course of acute fevers; superficial *ulcers* on the mucous surface, associated with disorders of digestion; *fissures* or "chapped lips," in cold weather; and *hypertrophy*, in strumous children. They also are liable to infective inflammations, the rare form of phagedæna in children known as *noma* or *cancrum oris* being specially fatal (*vide* p. 24). *Tuberculosis* in the lips usually takes the form of lupus. *Syphilis* occurs either as a *primary* chancre, which for a time may be mistaken for epithelioma (but it is generally surrounded by a zone of inflammation, is rapid in developing, and subsides under antisyphilitic treatment); or as mucous plaques in the *secondary* stages, which are very infective.

Angiomata are not uncommon on the margins; they may be removed by a small V-shaped incision, or if pendulous, with ligation. *Cysts* of the mucous glands occur in the lower lip, and may give rise to inconvenience by their size. They are apt to form again if simply punctured, and they should therefore be excised.

Epithelioma (of the squamous-celled variety) arises almost always on the lower lip, and occurs usually in smokers of short clay pipes, generally men, rarely women; and seldom before the age of forty. The disease begins at the spot where the pipe stem lies on the lip; and the heat of the pipe and the exudation of the acrid pyridine have doubtless special causative effects. In some cases, nevertheless, the condition may be traced to old fissures either of syphilitic or other origin.

Symptoms.—It commences as a small abrasion, a warty elevation, or a fissure, on the edge of the lip at the junction of the skin and mucous membrane. It increases slowly, but persistently in breadth and depth, and never shows any tendency to heal; the centre ulcerates, and the edges assume the typical thickened everted appearance. This may progress until the lip is wholly destroyed and the chin and bone implicated. The glands may become enlarged at an early stage from septic irritation derived from the ulcerating surface; and though it is usually some time before they are infected with malignant cells, once this happens, they increase rapidly in size, and soon involve their surrounding structures. The first to be attacked are the submental and submaxillary glands; and from those infection may spread along the carotid chain, and may press on the vessels, the vagus and sympathetic nerves, the trachea or œsophagus. Death usually takes place from sepsis and hæmorrhage; less commonly from metastatic infection of vital organs.

Treatment.—The tumour must be excised by a V-shaped incision, cut with a margin of at least $\frac{1}{3}$ inch beyond its limits. If this necessitates leaving a wide defect, flaps of skin may be separated at the sides of the chin and drawn up to meet in the middle line at the level of the lip margin. Other plastic operations may be done according to the requirements of the case. If the jaw is implicated a piece of it must be cut away with chisel or saw. The nearest corresponding glands should be removed.

Hare-lip, a congenital fissure of the upper lip, occurs if the fronto-nasal process fails to unite with either of the maxillary processes; if it fails to unite with both, a wide *median* or a *double hare-lip* results. If the fissure reaches the alveolus the palate is usually cleft also; and if there is a double cleft, the anterior part of the nasal process—the *intermaxillary bone* (or *premaxilla*)—attached to the front of the septum is distorted, and the alveolar edge projects forwards. The deformity may consist of a mere indentation in one side of the lip, or of an extensive fissure, which may be associated with cleft palate; and sometimes with the rarer form of *facial clefts* extending to the orbit; or anything between those limits. The nostril is usually broadened on the same side as the fissure, the ala being attached farther away from the centre than normal. Besides the actual cleft, the immediately adjacent tissues are less developed than usual; and if there is a middle process it is sometimes quite small.

Treatment.—The cleft must be closed by operation, as there is no tendency to spontaneous cure. The most suitable time to do it is when the child is quite young, between the third and sixth months; before that time even a small amount of hæmorrhage is badly borne, and after it, teething troubles are apt to interfere with successful treatment. For simple notches which do not extend to the nostril, an incision may be made more or less transversely in the lip above the notch, and the wound is drawn into a perpendicular line and there sutured (*Nélaton*). This may be done also at a later stage of the more complete operation if indentation develops in the cicatrix. In *single hare-lips* of greater depth the margins of the cleft are excised with a sharp knife, and the edges sutured together with silkworm-gut. The mucous membrane and the red margins of the lip must be adjusted accurately, as well as the skin surface. As the edges of the cleft are often unequal the shorter one should be incised laterally, or a small flap made by loosening the lower half of the margin instead of excising it (*Malgaigne*), and the raw edges drawn into a straight line and sutured to the opposite side. The soft tissues adapt themselves readily to these manipulations, and in order to get free mobility of the flaps, and so avoid tension, the lips may be separated subcutaneously from the gums; and the alæ of the nose may be loosened in the same way, and replaced in better position. As there is always cicatricial shortening of the scar, which may lead to indentation of the lip margin, sufficient allowance must be made for this, and the end of the suture line should project well below the line of the lip. The numerous operations invented for the different degrees of deformity vary in detail, but they all practically follow the principles of Malgaigne; of these the best known are the modifications of *Mirault* and *Giraldès*. *Double hare-lip* is treated in a similar way; the median portion being freed of its red margin all round, and sutured as an island in the middle of the lip, while the lateral flaps are joined together below it. Varieties of this operation have been introduced by *König*, *Hagedorn*, and others. If the *intermaxillary bone* projects it may be replaced between the lateral processes by first making a subperiosteal cut into the vomer, and then pressing back the bone, so that the fragments of the septum override (*Bardeleben*). If there is difficulty in bending in the bone, a small wedge may be taken out of its root instead. The edges of the bony processes may be rawed, and the pieces sutured together in the hope of getting bony union. The results of this proceeding are disappointing, as the intermaxillary bone almost always maintains some mobility, and the teeth are rendered useless for practical purposes; hence it is often better to remove the bone entirely, and the defect can be afterwards filled with a dental plate. The after-treatment of the operation is of some importance, as carelessness may lead to breaking down of the sutures. Feeding should be carried out with a spoon, and not with the breast or bottle. The nurse must also take care that the child is not asphyxiated by the narrowing of the mouth aperture, and should press her finger on the lower lip to keep it everted, till the child acquires the habit of keeping the lips sufficiently open.

Cleft palate is due to arrested development of the palatal portions of the maxillary processes, which fail to unite in the middle line. The fissure may be confined to the tip of the uvula, (*bifid uvula*); or to the whole of the soft palate; more usually it implicates part of the hard palate as well; and somewhat rarely all the hard palate and the alveolus, in which case there is usually a hare-lip in addition. There are other varieties of cleft,—of the hard palate alone, for instance, or median holes in the soft palate, but they are extremely rare.

The *effects* of cleft palate are due to want of closure between the nose and the mouth, and from exposure of the nasal cavities to irritation of various kinds. In the first place suction is impossible, and the child cannot take the breast or bottle. Secondly, speech is necessarily defective, as certain sounds cannot be expressed; and the child is late in making the effort, often as much as a year behind his fellows of similar age. He speaks with a nasal twang, and the voice is muffled. Further, from exposure of the nasal cavities, inflammatory diseases of all kinds are common, and there may be unnatural dryness; the senses of smell, taste, and hearing also may be impaired.

Treatment.—The child must be fed from birth with mother's milk poured slowly into the back of the throat with a spoon, or by a large flat teat through which it can flow without the aid of suction. If there is a hare-lip it should be closed early, as this facilitates feeding, diminishes the liability of exposure of the nasal cavities, and influences to some extent the tendency to narrowing of the cleft.

The operation on the palate should be performed about the third year, when the first dentition is completed, and before the child has learned to speak; before that age children stand the loss of blood badly, and, in all but the slighter forms of operation, that may be considerable. To obviate failure of the flaps uniting from sepsis the teeth should be examined, and all decayed ones extracted, and the sockets should be healed before the operation; any obstructive enlargement of the tonsils or adenoids should be cured; and the child should be free from cold at the time.

The operation most generally suitable is that of *Langenbeck*, and consists of closure of the cleft in the soft palate (*staphylorraphy*), and loosening of the soft parts over the hard palate, and joining them together (*uranoplasty*). The child is anaesthetised with chloroform, and laid on his back with the head hanging over the end of the table (*Rose's position*), so that the blood collects in the naso-pharynx and can easily be swabbed out. A couple of single gags may be used to keep the mouth open, as one can be removed from time to time to give more room. The anaesthetic is administered during the intervals of operating, pressure being applied meanwhile by the fingers and sponges on the palate to check the bleeding. The edges of the cleft are pared with a sharp knife; the soft parts are separated from the hard palate—a relaxation incision being made down to the bone along the alveolus on each side, from the hamular process to the level of the lateral incisors, so as to give a wide flap and a good blood-supply from the anterior naso-palatine arteries. If the posterior parts of the soft palate cannot be drawn completely together, the flaps may be relaxed by making a separate small incision across the levator palati, or perhaps more satisfactorily by cutting across or breaking the hamular process. The rawed margins of the cleft are then sutured together with silkworm-gut. Numerous needles have been devised for this operation, most of them being good, but the ordinary *Reverdin's* curved needle is the easiest to use, especially if the end of the suture is caught in the teeth of a long rat-tooth forceps, and inserted in the eye with its help. There must be no tension on the stitches, or they will cut through: even without this, or any apparent sepsis, some of the stitches may give way, and a partial breakdown is not uncommon. This, however, is usually remedied fairly easily by a later suture after the margins have been freshened.

After-treatment.—The child should be laid on his side to allow any discharge to flow out of the mouth; if blood is swallowed it is almost certain to set up vomiting and cause danger to the sutures. Milk and liquids only should be used as food during the first three or four days; speaking must be absolutely forbidden, and the mouth must not be opened more than is necessary for feeding: and the sutures are not removed for eight days or so. The mouth should be rinsed out with boracic lotion after each feeding; and if there is much tough mucous secretion about the nose and mouth it may be softened by steam inhalations. Care should be taken to avoid exposure to any source of infection during the healing process.

Very wide clefts may be bridged over by the method of *Davies-Colley.* A muco-periosteal flap is dissected up on one side, free at its sides and apex, and attached only behind at the junction of the hard and soft palates. On the opposite side a flap is dissected up and freed at the front, back, and alveolar side, but attached along the margin of the cleft. This is turned over as on a hinge, and the first flap twisted round so that both lie with their raw surfaces in contact above the cleft, and presenting a mucous surface to the nose and the mouth. The bridge is seldom large enough to fill the defect, but subsequent additions may sometimes be made.

Lately an important departure in the methods of treating wide clefts of the palate has been instituted by *Brophy.* It is undertaken before the bones are fully ossified, when they can be bent or moved without fracture; the most suitable age being from ten days to three months. It consists essentially in drawing the upper maxillae and palate bones of the opposite sides together by wire sutures. These are passed across the cleft from side to side above the level of the palate bone, one at the posterior extremity of the hard palate and the other near the front. The ends of the two wires on each side are twisted together over a lead plate, while the bones are forced inwards. In most cases it is necessary to make submucous incisions with a strong knife through the malar processes. The edges of the cleft are pared, and a few stitches may be placed in the mucous membrane. If there is an intermaxillary bone it should be freshened at its edges and forced into place. The results are often strikingly good, and development of the bones proceeds on more normal lines than without this treatment. The operation, however, is a severe one; there is often alarming extravasation of blood, and the immediate results are very unsightly; but the appearance improves greatly as healing takes place, and function becomes much better.

If operation is declined, or if all methods fail, the cleft may be occluded with some success by *obturators* attached to the teeth, and reaching back along the palate to fill up the gap.

Perforations of the palate are not infrequent from syphilitic necrosis, more rarely from tuberculosis. They may be closed after complete subsidence of the disease by plastic operations similar to those for cleft palate.

The uvula may become elongated as a result of repeated inflammatory attacks. It hangs against the tongue or pharynx, and gives rise to a tickling cough and hawking. It is treated at first with astringent applications; but if improvement does not soon take place the tip should be amputated. After cocainisation, the point is caught with a long forceps and cut off with a pair of curved scissors, in such a way that the raw surface points obliquely backwards as well as downwards. If there is much bleeding ice may be given to suck: the wound heals in three or four days.

Tonsils.—**Injuries** to the tonsil are rare; but any weapon perforating it may pierce the internal carotid or ascending pharyngeal arteries, from either of which severe hæmorrhage may take place. In such cases, if bleeding does not stop on pressure applied with the finger, or by the blades of a long forceps (one against the tonsil and the other on the outside of cheek), the internal, or the common carotid artery must be ligated.

Inflammation of the tonsils is very common, especially if they are enlarged or prominent; it is usually combined with some degree of pharyngitis. It takes the form either of *follicular* or *parenchymatous tonsillitis*, but these are often combined. It occurs chiefly in children and young adults, and is induced by cold, wet, exposure to noxious vapours, etc. It attacks rheumatic subjects especially, and is frequently preliminary to an attack of rheumatic fever. It is distinctly infectious, and sometimes epidemic.

Symptoms.—It usually begins with a rigor and a feeling of roughness and stiffness in the throat. This becomes located as a pain in the tonsil, and spreads to the ear, or to the submaxillary and sterno-mastoid glands, which soon become tender to the touch and prevent the mouth from being fully opened. Meantime the temperature rises (105°), and general febrile symptoms appear,—headache, pains in the back, constipation, and anorexia. The tongue becomes thickly coated and foul, the saliva accumulates in the mouth, and the breath is offensive. On examination, the pharynx and fauces are injected, the tonsil swollen, and (in follicular tonsillitis) its surface is covered with yellow specks of pus exuded from the follicles. These may be distinguished from spots of false membrane of commencing diphtheria by being easily removed with a swab; but if any doubt exists, they should be examined by the microscope or culture. Parenchymatous tonsillitis often goes on to formation of an abscess, which, if situated in the substance of the tonsil, displaces the gland inwards between the pillars of the fauces; in the more common form—*peritonsillar abscess*—the swelling appears in the upper part of the anterior pillar, which is pushed forwards, and fluctuation may be made out as pus becomes formed. The uvula is often œdematous and elongated.

Progress.—Follicular tonsillitis usually runs its course in a week from the commencement, and the symptoms subside gradually. If abscess forms the pain becomes more severe and localised, the fever remains high, and the constitutional disturbances, notably great prostration, are maintained. Complications are rare, but suppuration of the glands, and general infection through inflammation of the blood sinuses, should be mentioned. Septic intoxication of a rheumatic nature is a fairly frequent sequel; and acute tonsillitis may lead to a chronic inflammatory condition.

Treatment.—In the earliest stage, painting the tonsils and pharynx with a ten per cent solution of nitrate of silver may cut short a sore throat of this kind. At the beginning of the attack the bowels should be moved with a purge, and kept open with laxatives during the illness. In rheumatic cases salicylate of soda and quinine allay much of the pain and discomfort, and may prevent an attack of rheumatism. Iron is sometimes of use in modifying the intensity of the disease. The neck may be swathed with hot fomentations to relieve pain; and cocaine may be applied to the throat before the administration of food. Spraying the mouth with borax solution helps to keep it clean; but any antiseptic applied is probably valueless except for its mechanical effect. If an abscess forms, the best method of opening it is to plunge a closed sinus forceps into the swelling through the anterior pillar of the fauces, just at the level of the upper limit of the tonsil, where the pus is nearly always to be found. By this means the patient is not frightened with a sharp knife, and allows the throat to be handled at an earlier stage than otherwise; the wall of the abscess is easily penetrated by the narrow point, which of course can be widened by opening the blades, and danger to the blood-vessels is eliminated.

Chronic enlargement of the tonsils is very often met with in children, and is usually accompanied by adenoid vegetations in the naso-pharynx. It arises most frequently as a result of repeated attacks of acute tonsillitis, followed by inflammatory thickening and hypertrophy of the gland; but the enlargement is sometimes due to latent tuberculosis, and this is often the source of invasion of the cervical lymphatic glands. The crypts are apt to retain their secretion, and as this increases in amount it is exuded, or may have to be scooped out, as small stinking cheesy masses; sometimes it gives rise to *calculi*. The tonsils encroach on the faucial passages, and may even meet in the middle line; they cause a corresponding obstruction to swallowing and breathing, and this becomes aggravated at each attack of acute inflammation. The chief *symptoms* are snoring at night, pigeon breast in rickety children, and liability to acute pharyngitis; the voice is "stuffy," and deafness is not uncommon.

Treatment.—Although there is a tendency to diminution as age advances, moderate and great enlargements should be removed by amputation of the protruding portion, especially if there is enlargement of the cervical glands. It is best done with one of the ring guillotines made for the purpose; but if the swelling from its shape or position does not admit of its use, it may be caught with a toothed forceps and cut off with a probe-pointed knife. As the adenoids which are usually present are generally removed at the same time, it is better to use short general anaesthesia. In other cases 10 per cent solution of cocaine diminishes the pain. If there is much hæmorrhage after the operation, a pledget of wool dipped in adrenalin may be pressed against the stump. In very rare cases one of the large arteries may be injured, and the severe hæmorrhage may necessitate ligating one of the carotids. During the healing process the raw surface may be painted with menthol and cocaine to diminish the pain of swallowing. In slight forms of enlargement, and as a preparation for operation in others, iron tonics and cod liver oil internally, and iodine applied locally, have some influence in reducing the swelling. Crypts with foul contents should be incised and cauterised.

Tumours.—*Epithelioma* of the tonsil is usually an extension from the tongue, palate, or cheek, but it sometimes occurs as a primary tumour. It grows rapidly, and implicates early the lymphatic glands and the surrounding structures. *Sarcoma* occurs as a primary tumour and may be encapsuled; and if it is seen early enough it may be removed through the mouth by an incision behind the anterior pillar. Large tumours, if they are operated on at all, should be attacked from the back of the jaw; the bone must be cut through if necessary for access, and the lymphatic glands of the neck should be cleared out. The immediate prognosis is bad on account of shock and hæmorrhage; and the remote poor, from the early implication of distant organs.

Diphtheria is described in medical works, and is treated by the physician; but occasionally, in spite of the effects of antitoxin in modifying the disease, the surgeon is called upon to treat obstruction to breathing. This may be overcome by *tracheotomy* (vide *Affections of the Neck*), or by *O'Dwyer's* method of **intubation.** The tube is a heavy metal one which fits into the rima glottidis with a projection which prevents it from falling down, the weight and shape keeping it from being readily coughed up. It is introduced by means of an obturator fitted to a long handle which is bent to adapt itself to the shape of the mouth and pharynx. The finger of the left hand is passed into the throat till it just touches the larynx, and the instrument is guided along it by the sense of touch. The obturator is immediately loosened by a trigger and withdrawn. The child should be seated on a nurse's knee and held tightly round the arms and body, while an assistant steadies the head and keeps a gag in the mouth. The passage of the tube sets up violent coughing which may expel it, when it must be replaced. If it does not fit well, it may have to be removed soon, and for this purpose a loop of thread is previously passed into a small hole in the flange; when the irritation subsides the loop can be removed. Ultimately the tube is withdrawn by a special bent forceps. Intubation should not be substituted for tracheotomy if the membrane is very extensive, as the relief will be only temporary on account of its exuberant growth.

Stomatitis occurs most commonly in children, and is usually associated with disorders of digestion. It takes the *aphthous* form, in which the mucous membrane of the mouth is covered with white patches due to the growth of *oïdium albicans*; or the *ulcerative* form, with denudation of the mucous surface.

Treatment consists in correcting digestive troubles, for which grey powders are often useful; feeding with easily digested or peptonised food; and scrupulously cleansing the feeding bottles. Locally, glycerine of borax smeared over the mouth rapidly causes disappearance of the aphthæ. When ulceration is extensive the sores should be touched with nitrate of silver. In adults the mouth may be kept clean by sucking a chlorate of potash tablet.

Malignant stomatitis, see *Cancrum oris.*

Pyorrhœa alveolaris is a more severe form of *gingivitis* (inflammation of the gums), in which there is suppuration at the bases of many of the teeth. The edges of the gums are red, inflamed, and ulcerated; part of the roots are exposed, so that the teeth look unnaturally long; and there is usually a large concretion of tartar. A probe may be passed down alongside the teeth, and if pressure is made on the gums, pus wells up. The breath is usually unpleasant or even fetid; the general health suffers, and anæmia, tonsillitis, inflammation of the alimentary tract, and nephritis, have all been ascribed to this and similar forms of *oral sepsis*.

Treatment.—The tartar must be scraped off, and all loose teeth extracted. The mouth should be cleansed before and after meals, and on rising and retiring to bed. Rinsing alone is not sufficient: the gums should be wiped with gauze, in order to squeeze out the pus, the mouth being afterwards washed out with solution of borax or potassium chlorate. The gums may be hardened by touching them with a small pledget of cotton on the end of a burnt match dipped in alcohol (in the form of eau-de-Cologne or camphorated spirit), or in 5 per cent solution of formaline.

Tumours of the Jaws.—**Epulis** (composed of fibrous tissue either alone, or containing cartilaginous or bony elements) arises from the alveolus, periosteum, or gum; *odontoma*, solid or cystic, arises from the tooth follicles. The former is diagnosed by its firm consistence and slow growth; the latter by its appearance, site, and consistence. *Treatment.*—All such tumours should be removed, as there is a danger of malignancy supervening. The base should be exposed, and the tumour cut away by knife and chisel (*vide also* p. 59). If microscopical examination shows that the tumour is *malignant* a piece of the jaw should be removed along with it.

Upper Jaw.—*Tumours* may arise also from the **facial** aspect, the **palatal** surface, the **antrum**, or from the **cancellous** tissue. They may be innocent,—*fibromata*, single or multiple *osteomata*, or *cysts*; or malignant,—*sarcomata*, or *carcinomata*. Of those, myeloid sarcoma grows from the interior of the bone, the periosteal sarcoma from the external surface or the internal wall of the antrum; while the carcinoma grows from the mucous membrane of the palate or antrum, and may be primary or secondary to tumours of the mouth, naso-pharynx, or glands.

Symptoms in all are similar: the tumour, if it grows from the facial aspect, presents beneath the cheek; and if malignant, soon ulcerates, and gives rise to a foul discharge and hæmorrhage. If it grows from the antrum it fills up the cavity, and causes bulging of the walls and general broadening of the face. The bone becomes thinned and brittle, and may crack like an egg-shell when pressed upon with the finger, and an elastic swelling may be felt beneath it. If malignant, the tumour tends to burst through on to the cheek, or into the mouth; and invasion rapidly follows in the directions of least resistance, *i.e.* into the nasal fossæ and sinuses, and the naso-pharynx; or it may encroach on the base of the skull, or the orbit. There are usually foul discharge, increase of mucous secretion from the nose, and repeated hæmorrhages. There may be blockage of the tear ducts, with epiphora; or interference with the eye mechanism, with rigidity or paralysis of the eye muscles, or exophthalmos. The nose may become blocked on the same side, and a soft mass may be felt like a polypus in the naso-pharynx. The alveolus is apt to be necrosed and the teeth loosened, and there is difficulty of chewing and speaking. The lymphatics behind and below the jaw become infiltrated, especially in carcinoma. In the latter, too, pain of a severe neuralgic kind is an early symptom, and toothache without any obvious cause may be complained of for some time before the tumour is discovered. In these tumours also a preceding source of irritation is often noted.

Diagnosis.—The simple tumours are slow in growth, occur in young people, and do not bleed readily. In all doubtful cases they should be removed and examined microscopically. The malignant tumours occur in older people, grow rapidly, and soon break down; and pain, especially in carcinoma, is a marked feature. The sarcomata are more apt to bleed readily, and are less painful; and the myeloid variety occurs in younger people.

Prognosis in malignant tumours is very unfavourable. If the patient recovers from the operation he is liable to recurrence of the growth, except where the tumour is detected before it has spread beyond the body of the jaw, and a very complete removal carried out. The mortality is cited as 20-30 per cent, the chief cause of death being septic or "aspiration" pneumonia.

Treatment.—Simple tumours must be removed by the knife or chisel; and those growing from the antrum may require a temporary partial resection of the jaw. For malignant tumours the only rational treatment is excision of the superior maxilla.

If the tissues beyond the limits of the jaw are infiltrated it is unwise to attempt eradication; and in those cases no operation should be done except what is necessary in the way of removal of necrotic tissues by curette and cautery for the relief of sepsis and hæmorrhage. As *excision of the upper jaw* is one of the bloodiest in surgery, it is difficult to prevent the entrance of blood into the air passages; but a partially bloodless field of operation may be obtained by stopping the carotid circulation of one side, with a permanent or temporary ligature, or with bull-dog forceps; when the jaw is removed, and the cavity packed, the forceps or ligature is released, and the small wound in the neck closed. Rose's position of the head (p. 307) cannot be employed, as the bleeding is so much aggravated; and indeed, many surgeons operate with the patient half sitting up in order to lessen the blood flow. In the latter case, anaesthesia with chloroform is counter-indicated; and the patient is well drugged with morphia or morphia-scopolamine, and a whiff of ether given at the commencement to dull the pain of the skin incision, while the rest of the operation is carried out almost without anæsthesia. Other operators prefer a preliminary tracheotomy, using *Trendelenburg's canula.* A better plan is to use an ordinary tracheotomy tube, and pack the pharynx with a firm turkey sponge which is removed at the end of the operation; in this way any discharge is prevented from entering the lungs. The skin incision (*Dieffenbach's* and its modifications) is made in the middle line of the upper lip, continued round the ala, and up the side of the nose to near the inner canthus, and extended if necessary along the lower margin of the orbit. The bone is bared along the front and inside the orbit; and the soft palate, if it can be saved, is cut across behind the hard palate. The bone is divided by sawing across the malar process and the hard palate and alveolus in the middle line, while the nasal bone is cut through with bone forceps. The other attachments are severed by seizing the jaw with a lion-forceps and twisting it out. The cavity is packed with iodoform gauze, and the skin wound closed. The lymphatic glands of the submaxillary and pterygoid region should be excised if they are enlarged; and permission should be obtained beforehand to remove the eyeball if the contents of the orbit are found to be infiltrated.

After-results.—Though there is always some puckering of the face, it is remarkable what little deformity is left after such an extensive operation. There is sometimes downward dislocation of the eyeball; and there is always a defect in the roof of the mouth, which may be improved by the use of an obturator.

Temporary resection is carried out by a similar flap, with its base towards the cheek, so as not to interfere with the branches of the facial artery and nerve. The front of the maxilla is removed by chisel or saw along with its coverings of periosteum and skin, and turned back to expose the interior of the bone; the flap is replaced and fixed by suture when the tumour has been removed.

TONGUE.

"**Tongue-tie**" is due to abnormal shortness of the frænum, which may interfere with proper suckling; and it is for this reason alone that any operation need be done. The frænum is snipped with scissors. Children are often brought to the surgeon who have slight shortening of the frænum, but no impairment of movement of the tongue; others are brought for "tongue-tie" in whom there is none whatever, but where the defect is in the intellect.

The thyro-glossal duct sometimes does not close, and (*a*) the upper part may remain as a patent lingual duct, or (*b*) the lower part develop as a congenital cyst in the floor of the mouth or in the neck.

Wounds of the tongue occur from biting, especially during an epileptic fit, and in many other ways. The chief danger is from hæmorrhage; but that once stopped, healing takes place so readily that an attempt should be made at suture, even in cases of extreme laceration.

Glossitis.—Inflammation is rare in the *acute* form, but when it occurs from stings of insects, mercurialism, etc., it may end in suppuration and abscess.

Chronic inflammation is common as the result of irritation —at the edges, from jagged teeth, and on the dorsum, from smoking, etc.; it appears to be induced also by dyspepsia and syphilis. There is superficial hyperæmia which leads eventually to proliferation of the epithelial cells. This may give rise to a flat scaly covering (*psoriasis*), or to a rough papillomatous-like surface (*ichthyosis*); but more commonly it results in the condition of **leucoplakia**, in which there are smooth, milk-white patches on the dorsum and sides. On palpation these feel firm and elastic, or hard like horny plates. In other cases the epithelium becomes atrophied, and the tongue presents a glazed red surface. There is no pain unless ulceration takes place, and the condition is often overlooked until accidentally it is discovered by the medical attendant. Leucoplakia is a very frequent precursor of epithelioma of the tongue, though only a minority of cases is followed by cancer.

Diagnosis is to be made from the plaques of secondary syphilis, which occur in the early (secondary) stage, are acute at first, remain soft, and are usually accompanied by other syphilitic manifestations and by enlargement of the glands.

Treatment.—All irritation must be avoided, *e.g.* drinking hot liquids, pure spirits, using strong condiments or mouth washes; and smoking must be prohibited. Decayed teeth must be extracted, and all foci of sepsis removed; and the mouth must be kept clean by wiping and rinsing with weak borax solution. A careful watch should be kept lest any signs of ulceration appear in spite of treatment; if this happens, the patch should be excised and examined with the microscope, and if it is found to be cancerous, the half or the whole of the tongue must be amputated.

Ulceration.—**Simple ulcers** may arise from dyspepsia or from irritation of jagged teeth, etc. They are superficial, and unless of long standing show little induration of their bases. They arise also in the hardened surface of leucoplakia.

Treatment.—All sharp edges of teeth or tooth-plates must be filed smooth or otherwise made harmless, and digestive troubles must be corrected. Locally, borax and glycerine mixture is the most suitable application.

Tubercular and *actinomycotic* ulcers are rare, and are very resistent to treatment. The affected part should be excised; and in actinomycosis iodides should be tried.

Syphilitic ulcers occur in all the stages. *Primary* chancre of the tongue is rare, and is always accompanied by swelling of the lymph glands. *Secondary* ulcers are very common, and are usually associated with mucous plaques. They heal rapidly under the influence of mercury, but tend to return when treatment is left off. The *tertiary* lesions occur first as hard, round gummata in the anterior part of the tongue.

They are usually single, and confined to one-half. The mucous covering becomes smooth as the papillæ disappear and the centre breaks down, and discharges a thin fluid and small necrotic particles. The edges are undermined, and the base has a dirty yellow colour.

Diagnosis, from simple ulcers, by the history, the thickened base and its colour, and the tendency to spreading necrosis; also from cancerous ulcers.

Treatment consists of oral antisepsis and iodides.

"**Lingual tonsil**" is a rare condition in which there is hypertrophy of the lymphoid tissue at the root of the tongue in front of the epiglottis. This may attain to considerable size, and if it causes obstruction it must be removed.

Tumours of the tongue.—*Hæmangiomata* occur sometimes, and are liable to hæmorrhage.

Lymphangioma in the form of **macroglossia** is a rare condition in which the tongue is infiltrated with irregular sinuses containing lymph, or sometimes blood (*mixed angioma*). The surface is covered with vesicles, which break down and ulcerate if the tongue is too large to be retained in the mouth. (Another form of *macroglossia* occurs in idiots, from simple hypertrophy of the tongue; it also is rare.)

Treatment.—In slight cases the tumour tissue should be destroyed with the thermocautery. In severe cases a wedge-shaped piece should be excised.

Cancer of the Tongue.—Epithelioma is more common in males, and occurs chiefly between the ages of forty and sixty, but has been seen as early as twenty-five. It is preceded in most cases by some form of chronic irritation such as excessive smoking, and in many cases it follows leucoplakia. Two forms may be distinguished in the earliest stages: a nodule in the depth of the tongue arising from the glands in the mucous membrane, and covered with epithelium until it ulcerates; the other, superficial from the beginning, and ulcerating very early. In both the tumour is hard, and the limits are not well defined, but fade gradually into the surrounding tissues. The ulcer is crater-like, with elevated thickened edges, and the base has a dirty yellow and furrowed surface, from which small pearl-white nodules may sometimes be squeezed. The most common site of cancer is at the side of the tongue opposite the bicuspid or molar teeth. It may arise farther back, near the circumvallate papillæ, in which case the epiglottis is implicated early. Pain of a sharp neuralgic character is a constant and early symptom, and it may lancinate towards the ear; and there is usually a copious flow of saliva. Invasion of the surrounding tissues first affects the floor of the mouth, then the maxilla, the fauces, tonsils, and cheeks. The tissues around the jaw and its articulation become so matted together that at last the mouth cannot be opened; and there is great difficulty of feeding, and sometimes of respiration. The foul discharge from the ulcerating surface often induces septic pneumonia from which the patient dies. The lymphatics are infected early, recurrences after operation taking place much more frequently in the glands than in the scar. The glands which drain the tongue are—(*a*) the *submental*, some of which lie in the substance of the tongue between the genio-hyoglossi muscles: (*b*) the *submaxillary*; and (*c*) the *deep cervical* glands on the jugular vein near the bifurcation of the carotids. From these infection may spread to the supraclavicular glands. Dissemination in distant organs, however, is not common. Infection of either side of the tongue is apt to spread to the lymphatics of *both* sides, as there is a free communication of the lymph vessels in the median line. If there is much ulceration, the glands may be enlarged and soft from absorption of septic matter.

Diagnosis must be made from *simple* ulcers resulting from irritation, by their cure after removal of the cause, and treatment with bland mouth-washes, and by the absence of induration at the base or enlargement of the glands. From *syphilis* the differentiation is often difficult; in case of doubt, iodides or even mercury should be tried, but if there is no unmistakable amelioration in four weeks this treatment should be abandoned. The more characteristic differences are—in *cancer* the tumour is solitary, its site is at the edge of the tongue near the molar teeth, the base of the ulcer is necrotic and bleeds readily on touching, pain is constant, the glands are enlarged early, and leucoplakia is often present at the edge of the ulcer; while in *syphilis* the nodules may be multiple, the commoner sites are the tip and middle, the base of the ulcer is friable, but not liable to bleed if particles are picked off, pain is slight or even absent, the glands are rarely enlarged, and leucoplakia is not so common. Microscopical examination often gives indefinite information, unless a fair-sized piece is taken, in order to get a characteristic appearance.

Prognosis.—An operable case is one in which incision can be carried at least $\frac{1}{3}$ inch into the sound tissue beyond the limits of the tumour; and it must be possible to remove all the diseased glands by clean dissection. The mortality from the more severe operations is high, but these are necessitated by the extent of the disease. If removal is not free enough, recurrences are sure to arise.

Treatment.—The only effective treatment is excision. If the tumour is situated near the front, resection can be done through the mouth—small tumours being removed in a wide V-shaped incision, which is closed by suture. For large tumours the affected *half of the tongue* must be excised; the tongue is drawn out of the mouth by a long stitch through the sound side, and split down the middle with scissors, the mucous membrane on the floor of the mouth divided and separated from the under side, and the half tongue cut across as far back as possible, while an assistant stands by with a pressure forceps to clamp the stump as it is cut. In this way (*Whitehead's*) little blood is lost, and the arteries can be caught and tied at leisure. If secondary hæmorrhage occurs, the lingual artery may require to be tied; but as a rule preliminary ligation is not necessary in these cases. The lymphatics in the submental and submaxillary region should be cleared out whether enlarged or not, at the same time, or soon after. If the cancer is situated farther back, and if it has spread to the adjacent tissues, a much greater exposure is necessary; and if the disease has spread beyond the middle line, the *whole tongue* must be excised. The cheek may be split up to the ramus of the jaw; or the floor of the mouth may be opened by a flap incision (*Kocher's*): the tongue is drawn out and amputated, after clearing the muscles off the jaw. If the tumour is adherent to the bone, it may be necessary to split the jaw in the middle line, separate the halves, and cut away all the affected bone; this incision gives very free access to the root of the tongue, and is most useful also for treating extensions to the faucial region. The cut jaw is replaced and sutured with wire; but when the bone is extensively infiltrated a part must be excised. The deformity is sometimes considerable, but it can be corrected to some extent by a dental plate. If the lymphatic glands are exposed during the operation, they must be removed: if not, they may be excised a few days later, when the patient has recovered from the first operation; in this way the shock of a very extensive dissection may be postponed.

The raw surface should be painted with *Whitehead's varnish* (Friars' balsam and iodoform), and packed with iodoform gauze; and the edges of the mucous membrane must be approximated and sutured wherever that is possible, so as to diminish its extent. In all cases a preliminary tracheotomy may be done; and that is usually necessary when the limits of the disease reach near to the epiglottis. Food must consist of liquids only, for the first few days, administered if necessary through a tube; and this may be supplemented with enemata.

The chief dangers are primary and secondary hæmorrhage, and septic pneumonia from inhalation of blood and discharge. The patient may be operated on in the semi-sitting position, (with precautions mentioned on page 316); and, as soon as possible, he should be encouraged to sit up in bed, in order to prevent hypostatic congestion of the lungs.

Cysts.—Ranula is a cystic dilatation from obstruction, by salivary calculus or otherwise, of the sublingual or submaxillary glands or their ducts, and occasionally of the other small (mucous) glands in the floor of the mouth. The cyst appears as a bluish white, grape-like body below the tongue, slightly to one side of the middle line. If punctured it emits a glairy fluid. It may grow to a large size, and displace the tongue upwards and the floor of the mouth downwards.

Treatment.—The cyst should be excised with its walls, except where it is seen very early, when it may be incised, and the interior cauterised and packed with iodoform worsted, and allowed to granulate.

Dermoids and other cysts are rare, and usually arise in the middle line.

Lower Jaw.—In all *inflammatory* infective diseases the progress is apt to be insidious and the healing process slow; the bone is so tough that the diseased particles are protected by a barrier too hard to be removed with the ordinary spoon, hence it is often necessary to use a gouge or chisel for this purpose.

Phosphorus necrosis occurs amongst workers in yellow phosphorus, from inhalation of the fumes, and occasionally in others from internal administration. In the former the jaw is attacked through the medium of a decayed tooth, from which a necrosing inflammation spreads; numerous sequestra are formed and sinuses from which a foul discharge exudes. There is a great development of spongy involucrum around the dead pieces. In some cases tubercle bacilli have been found in the discharge, but this is by no means universal.

Treatment.—The necrosed part should be removed as soon as possible to prevent further extension. Prophylactic measures consist in avoiding the use of yellow phosphorus.

Tumours.—The chief are *odontomata* and *sarcomata.* The latter are removed by excision of the part of the jaw from which they spring, leaving if possible some of the arch to preserve the shape of the chin and alveolar line. Sometimes it is necessary to excise the entire half of the jaw.

Temporo-maxillary Joint.—Arthritis may arise from otitis through the Glasserian fissure; spreading septicæmia, as in gonorrhœal infection, rheumatism; or arthritis deformans.

Closure of the jaw depends on (*a*) spasm of the muscles from hysteria, reflex irritation of wisdom teeth, etc., or from peripheral nervous influences (as in facial spasm), or central (as in tetanus); (*b*) on ankylosis resulting from cicatricial shortening of the soft parts, after burns, sloughs from acute infective inflammations, etc.; and (*c*) the result of adhesions between the joint surfaces from old injuries or inflammation.

Treatment.—In functional stiffness the mouth should be wedged open, and a spring gag may be worn to keep it from closing. In true ankylosis of the joint, or its surrounding soft parts, this is seldom effective or sufficient; and subcutaneous section of adhesions is also of little help. A wedge-shaped piece should be cut out of the angle, dividing the bone across, and a false joint encouraged to form at this point. Other methods, as excising the condyle, or osteotomy of the neck, usually only lead to return of the ankylosis.

CHAPTER IV.

INJURIES AND DISEASES OF THE NECK.

Cervical Rib.—The supernumerary rib is always attached to the seventh cervical vertebra, and may attain to full development as a rib, or remain merely as an outgrowth from the costo-transverse process. It very rarely causes any trouble or inconvenience; but occasionally there are disturbances of the circulation in the arm of the same side, and sometimes pressure on the nerves. Diagnosis is made by palpation and X-rays.

Treatment.—The rib, if it causes inconvenience, may be excised, sometimes a difficult and dangerous proceeding, as the pleura and many of the important structures in the neck may be in close relationship.

Congenital defects in the neck comprise *lateral* **cysts** and **fistulæ,** the remains of the unclosed second branchial cleft; and similar affections in the *middle* line arising from the thyroglossal duct. Either may be complete fistulas; but more commonly they begin as cysts (*i.e.*, localised defects of obliteration, filled up and dilated with secretion), which ultimately burst. A lateral fistula may have its opening at any part of the neck, median or more frequently lateral; the other opens always in the middle line. The fistulæ and open cysts continue to secrete a thin fluid from their epithelial lining, which may give rise to troublesome eczema. *Median cysts* may be confused with tubercular abscesses, sebaceous cysts, dermoids, and (in the tongue) ranulæ.

Treatment.—Complete excision is the only sure method; and it may be difficult on account of the deep situation and the intimate relations with important structures. Injection of irritant fluids for the purpose of causing adhesive obliteration of these tracts is usually insufficient; and in the lateral fistulæ the fluid may enter the larynx through patent communications.

Wry-neck arises from shortening of the sterno-mastoid; it occurs at, or shortly after, birth, and is nearly always unilateral. It is ascribed to (*a*) rupture of the muscle during a difficult delivery, resulting in laceration and hæmatoma, and giving rise to a hard swelling (sometimes resembling cartilage or bone), which gradually subsides, with subsequent contraction; (*b*) inflammatory infiltration and cicatrisation; and (*c*) ante-natal influences, probably traumatic. It arises also later from other causes, such as rheumatic inflammation, adhesions to cicatrices of the overlying skin, and from hysteria. The *spasmodic* variety arising from irritation of the spinal accessory nerve is discussed on page 140.

Symptoms.—The head is bent to the affected side, and the face turned to the opposite side. In well-marked cases there is curvature of the cervical vertebræ, and the entire head may be displaced to the affected side, or sometimes to the opposite side. On straightening and rotating the neck, the sterno-mastoid stands out as a firm cord, and those manipulations are usually painless.

Diagnosis.—The continual tenseness of the muscle when pulled against, and the persistence of this under anæsthesia, distinguish this form from spasmodic wry-neck.

Treatment. — Early treatment consists of massage, overextension, with exercises when the child is old enough. A poro-plastic splint may be worn at night with the head in the overcorrected position, but it should be taken off in the daytime, and exercises encouraged. When the deformity has become permanent, the tendon should be cut across at the sterno-clavicular insertion, either by subcutaneous tenotomy, with care not to wound the jugular vein, or more safely through a small flap incision; and in rebellious cases the whole muscle may be removed. The head is put up in a plaster or starch case in the overcorrected position until healing has taken place; and exercises should be continued for some time afterwards. When the defect is due to cicatrisation of the skin, the muscle should be loosened from the overlying structures. Hysterical cases must be treated by suitable medical and moral means. Spasmodic wry-neck should not be treated by tenotomy; nor should the nerve be touched in the non-spasmodic cases.

Wounds of the neck comprise those made in the air passages and elsewhere by the surgeon, and cut throat wounds.

Tracheotomy is performed for (1) relief of respiratory obstruction in the naso-pharynx or larynx by foreign bodies, diphtheritic false membrane, œdema of the glottis, or other swellings; (2) for removal of foreign bodies in the larynx, trachea, or bronchi; (3) for administration of anæsthetics and air during operations in the upper air passages, in order to prevent the entrance of blood or other matter into the lungs; or (4) as a permanent opening in the case of tumours or constrictions, or after extirpation of the larynx.

It may be performed above (*high operation*), or below (*low*) the isthmus of the thyroid gland. In children it is usually done above, on account of the shortness of the neck; or the isthmus may be divided between clamps and the edges retracted. Anæsthesia with cocaine is quite sufficient in adults; but children should have a whiff of chloroform or other general anæsthetic to prevent struggling. In cases of asphyxia from diphtheria little or none is required, and very little allowable on account of the toxic nature of the disease.

The operation in adults is straightforward and easy. A narrow sand-bag is placed under the neck, the trachea steadied with one hand, and an incision made down to it in the middle line. Bleeding is stopped by pressure forceps, the edges of the wound and the sterno-hyoid muscles are retracted aside, and the isthmus downwards (or upwards). The trachea is caught with a sharp hook or toothed forceps, opened in the middle line by plunging in the knife and cutting forwards, dividing two or three rings, and the edges held apart with a dilator or a pair of hooks. When the trachea is opened a deep inspiration is taken, and the cold air at once sets up violent coughing; and mucus, blood, etc., are expelled. This is taken advantage of in cases where a foreign body has got into the trachea or bronchi; it is usually immediately thrown up into the larynx, where it may be caught and picked out, or if the tracheal wound is held open sufficiently, it is often expelled. When the initial coughing has subsided, a canula suitable to the size of the patient is introduced and fastened by tapes passed round the neck. The bleeding points are all tied, and an iodoform gauze pad is placed on the edges of the wound.

Difficulties.—In children the neck is short and often fat: the veins in asphyxial conditions are congested, obstruct the field of operation, and bleed profusely if wounded; the trachea is narrow and soft, and is easily missed in the neck, unless clearly defined and exposed; and the operation is often one of emergency, and has to be done with little assistance in unsuitable and ill-lighted rooms. *Care* must be taken not to pierce the posterior wall of the trachea; to make the incision exactly in the middle line, and large enough to admit the canula with ease; to avoid passing the tube between the fascia and trachea, or between the wall of the trachea and a false membrane; to avoid unnecessary wounding of the vessels; and to stop all bleeding before opening the trachea, even at the risk of losing a little time.

After-treatment.—The room should be kept at an even and fairly warm temperature, and the air moistened with steam vapour from a kettle, or by a large hollow honey-comb sponge wrung out of warm water placed over the neck. It is not usually advisable to erect a tent over the patient, as it is apt to cause dampness of the bed-clothes, and unnecessary risk of chill. The canula must be cleared of mucous secretion, which is apt to dry and cake on it, by removing the inner tube and washing it. In *diphtheria* cases antitoxin is administered at the earliest moment, and may check the formation of membrane; but sometimes this spreads downwards below the edge of the tube, and blocks the air passage. It should be cleared out with a feather or a soft wire-stemmed brush (such as a pipe-cleaner), and a longer tube inserted. Diphtheritic infection of the edges of the wound may occur, but it is not common. The prognosis in those extensive cases is not good.

If blood is seen in the discharge it may be due to *ulceration* (*decubitus*), from pressure of the tube against the back or the front of the trachea, or of the edge of the wound on the tube; a black mark (sulphide) on a silver tube also indicates that it is in contact with necrotic tissue. In the former case the tube must be changed for one of different length or curve, and in the latter for a narrower one. When a tube has to be worn for a long time a rubber one may be substituted; but a metal one must be used until the wound has become permanently shaped, otherwise the elasticity of the tracheal rings will compress the tube. *Stenosis*, with signs of dyspnœa, may arise from granulations (and false membrane); from œdema due to perichondritis, the result of a pressure sore; and from compression by distortion of the tracheal walls. A late effect is *paralysis* of the larynx, which compels the patient to continue the tube. It is due to inflammatory thickenings and adhesions, to "habitual" want of use of the laryngeal muscles, or to post-diphtheritic paralysis. Organic obstructions should be treated by intubation with graduated bougies; habitual weakness by blocking the canula from time to time to compel the larynx to work; and true paralysis by nerve tonics and electric stimulation.

Crico-thyroid laryngotomy (incision of the crico-thyroid membrane) is sometimes done in urgent cases where time cannot be spared, as the site for operation is very readily found. The oval-shaped space between the lower edge of the thyroid cartilage and the upper edge of the cricoid is felt for, and the knife plunged into it and carried across transversely; the wound is drawn open with any hook that is handy. There are difficulties in the operation: hæmorrhage from the crico-thyroid artery which runs across the upper part of the space; if a tube is used it must be small; the nearer the wound is made to the larynx, the greater the liability of loss of voice from granulations spreading to it. The operation is not recommended as a deliberate measure, except where the trachea is encroached upon by growths of various kinds.

Laryngo-tracheotomy is an incision of the trachea, prolonged by dividing the cricoid cartilage.

Thyrotomy is splitting the thyroid cartilage, for the purpose of removing tumours, etc., from the inside of the larynx. The cartilage should be cut from within outwards, in order to make the incision evenly between the vocal cords without wounding either; in adults it is often ossified, and should be divided with a Gigli's saw; and more room may be obtained by dividing the ligamentous bands along the upper and lower margins. If possible the vocal cords should be spared; but in malignant cases no sparing of the voice is recompensed by leaving any diseased tissue behind. When the tumour is removed the halves are allowed to spring together; and they should be fixed with sutures, as any inaccuracy in adjustment of level or angle leads to failure of the voice. In order to prevent that, the thyroid cartilage may be cut across (*transverse thyrotomy*) above the level of the true vocal cords; in this way their relationship is not disturbed. To get freer access to the false vocal cords the upper part may be split as in the preceding operation. If the cricoid cartilage is split too it is called *total laryngotomy.*

Subhyoid pharyngotomy is opening the pharynx through the thyro-hyoid membrane.

Foreign Bodies in the Air Passages.—Loose bodies in the mouth may be drawn in by sudden inspirations during coughing, crying, laughing, etc. Pieces of food and rough bodies may lodge in the *pharynx*, or in the *larynx*, where the irritation causes spasm of the glottis, preventing them from falling down farther. If the body is small, it may be expelled by coughing; otherwise it must be extracted with laryngeal forceps. If large, it may become impacted between the false cords, and there is immediate danger to life from asphyxia; tracheotomy or laryngotomy must be performed without delay, after which the foreign body may be extracted at leisure. If the body passes to the *trachea*, it causes fits of suffocation when coughed up against the glottis. On auscultation sibilant rhonchi are heard, and possibly movements of the body up and down. If not extracted soon it may cause fatal spasm of the glottis, or become impacted in a *bronchus.* The right bronchus is the one into which it more commonly falls. If the main bronchus is completely blocked, respiratory sounds on that side are absent, and collapse of the lung gradually comes on; if partially blocked, loud musical sounds are heard. If the blockage is in one of the bronchioles, the corresponding part only of the lung is affected at first. Continued presence of a foreign body causes pain and fits of coughing; and after a time necrosis in the immediate neighbourhood, with abscess or gangrene of the lung, is apt to occur. The body may become loosened in this way, and at any time; and it may be expelled into the trachea, or out of it if there is a large enough tracheotomy opening. In other cases death occurs from septic phthisis. Occasionally the body becomes encysted, and gives no further trouble.

Treatment.—For foreign bodies in the *lower* air passages, inversion of the patient may be tried in the first instance by leaning his body over the edge of a bed or table, with his hands on the ground, followed by shaking and thumping; if it is not successful, tracheotomy should be performed. Sometimes the body is impacted, and only becomes loosened after a few days, when it is coughed up; and time should always be allowed for this to take place. If this fails, a long loop of bent wire may be passed down in the hope of catching it. Should a bronchoscope be available, an attempt should be made to locate the body and extract it with forceps. The instrument may be passed through the mouth, with the head in Rose's position, or through the tracheotomy wound (*Killian*).

Laryngectomy, partial or complete (*extirpation*), may be required when the larynx is affected with malignant disease of too great extent to be removed by intralaryngeal methods, or by thyrotomy. The trachea is cut across and the lower end stitched to the skin incision. A canula is inserted and packed round with gauze (or a *Hahn's* canula already surrounded with sponge may be used), and the anæsthetic continued through this. The larynx is exposed in its whole length by a median incision, with division, if necessary, of the isthmus of the thyroid gland; the soft structures are dissected off all round, and the larynx is then cut across below the hyoid bone. All bleeding is stopped, the cavity packed with iodoform gauze, and the wound closed by temporary sutures. In order to prevent the entrance of fluids into the large granulating cavity, and septic products from thence into the trachea and lungs, the skin and muscles may be sutured against the cut end of the pharynx so as to obliterate the cavity. Or if the trachea is very movable, the cut ends of pharynx and trachea may be stitched together with a circular suture.

Partial Laryngectomy.—If the disease is limited to one side, the affected side only, or a part of it, need be removed, the defect becoming covered with granulations. In this case there is an almost equal danger from sepsis, owing to the lack of means for protecting the raw surface.

After-results.—The chief danger is aspiration pneumonia, which is the most common cause of death after such operations: it may be diminished by employing the modifications mentioned above. Other complications are cellulitis in the neck, spreading perhaps to the mediastinum; secondary hæmorrhage; and fatal "delirium cordis" occurring 24-48 hours after the operation, and attributed to interference with the depressor fibres of the vagus and superior laryngeal nerves. The mortality of all these operations for removal of malignant disease (laryngotomy and laryngectomy) is still great, but the percentage of cures of three years' standing justifies operation; and the usual rule holds good, that the earlier a radical operation is permitted the less is its extent and danger.

Cut-throat wounds are generally suicidal; and, being made usually with the right hand, extend from left to right across the neck. The commonest sites are about the crico-thyroid membrane, the most prominent place when the head is thrown back. The projection of the larynx protects to some extent the great vessels, and unless the wound is well to the side they often escape—the jugular veins being the most readily severed. The larynx may be opened in any of the regions mentioned above, and the cut may penetrate to the œsophagus or the vertebral column. The first danger to avert is hæmorrhage, which may cause syncope, or, by entering the air passages, asphyxia. The later dangers are aspiration pneumonia; sepsis, with perichondritis and œdema in the trachea; cellulitis of the deep planes of the neck; secondary hæmorrhage from the cut vessels; surgical emphysema from entrance of air into the loose tissues; cicatricial stenosis and other late effects; and fistula in the trachea or œsophagus.

Treatment.—All bleeding vessels must be clamped, and means taken to restore the circulation; the larynx must be freed from blood; and if there is oozing from the edges of the wound, a tracheotomy tube may be inserted and packed round with gauze. The wound is thoroughly cleansed, and the openings in the trachea or larynx closed by suture, and the vessels tied. The superficial part of the wound is packed with iodoform gauze, and only partially closed, the packing being withdrawn as the cavity fills up. The various complications are treated as they arise.

Contusions of the neck, from falling across a sharp edge, or from being suddenly caught against a rope, may result in *fracture* of the hyoid bone, or in *rupture* of the thyroid, or cricoid cartilages, or the trachea. In the former there is pain and difficulty of swallowing, and crepitus may be felt; in the latter cases there is internal swelling, from extravasation of blood or œdema, and, if the attachments of the vocal cords are displaced, hoarseness or aphonia, there may be also extensive surgical emphysema.

Treatment.—The patient is laid in bed, with the head kept between sand-bags, and ice or cooling lotions are applied to the neck. All attempts at swallowing or speaking should be avoided as much as possible. Alimentation may be carried out for some days by the rectum, or through the stomach tube. If there is œdema or emphysema causing dyspnœa, tracheotomy must be performed without delay.

Cellulitis of the deeper planes of the neck may spread in any direction, and even extend to their extreme limits, *e.g.* into the axilla or mediastinum. Owing to the confinement by the dense fasciæ, especially in the submaxillary space and that around the great vessels, septic absorption is apt to be intense, and lead to rapidly fatal results (**Ludwig's angina**). It arises from infection starting in decayed teeth, ulcers of the mouth, inflammation of the tonsils, etc. and sometimes from suppuration of lymphatic glands.

The **symptoms** begin after a slight toothache, sore throat, or the like, and reach their height in three days or so. There is high temperature, quick and thready pulse, dry tongue; and general asthenic febrile conditions soon appear. The neck is swollen and œdematous, and sometimes purplish in colour; and if there is much pressure on the air passages, the face is cyanosed. Fluctuation is not readily made out, but tenderness extends all over the neck. There is difficulty of swallowing, and there may be inflammatory œdema of the floor of the mouth. If suppuration is not relieved by bursting through the skin or by incision, death may ensue in a few days, from œdema of the trachea or larynx by extension of the inflammation, or from exhaustion due to absorptive poisoning.

Treatment.—The tissues must be promptly incised, and opened up by Hilton's method, in the middle line, in the axes of the sterno-mastoids, and below the jaw. Tracheotomy must be done if there is threatening asphyxia; and anti-streptococcic serum should be injected if the pus is seen to be due to streptococci.

Lymphatic Glands.—**Inflammation** of the glands is very common, both in the acute and chronic forms; and follows irritation of various kinds in all parts of the head and neck, depending on their situation. The *suboccipital* and *mastoid* glands drain the posterior part of the scalp; and the *posterior auricular*, most of the external ear; the *submental* or *suprahyoid* glands, between the anterior bellies of the digastrics, receive lymph vessels from the middle of the lower lip and chin, and the front of the tongue; the *submaxillary* glands, situated in the digastric triangle, from the face, buccal cavity, lower jaw, and part of the tongue and pharynx; the *superficial cervical* glands, lying along the line of the external jugular vein on the sterno-mastoid, from the external ear and side of the head; the *deep cervical* glands, lying beneath the sterno-mastoid along the carotid sheath, (*a*) the *upper set*, from the cranial cavity, orbit, nose, tongue, and upper parts of the pharynx, larynx, and œsophagus, and (*b*) the *lower set* in the supraclavicular fossa, from the lower part of the œsophagus, larynx, trachea, thyroid gland, and also from the chest wall and axilla; and the *retro-pharyngeal* glands, from the naso-pharynx.

Acute adenitis, secondary to acute conditions in the regions mentioned, may go on to suppuration, and the abscess may burst externally, or give rise to symptoms similar to those of *Ludwig's angina.* Suppuration of the mastoid glands may arise from pediculosis and eczema of the scalp, and simulate in some respects *mastoiditis.*

Chronic adenitis may persist for some time after the primary focus has healed, and may be subsequently the seat of tuberculosis. Chronic enlargement may also appear without an acute stage, in association with enlarged tonsils, adenoids, and carious teeth.

Tuberculosis.—The most common cause of glandular enlargement is tuberculosis; and the neck glands are by far the most frequently attacked of any. The disease is probably always secondary, but the primary tubercular foci, except those occurring on the skin, are rarely to be detected. The points of entrance of the bacilli are probably situated in carious teeth, enlarged tonsils, and the mucous membrane of the mouth and naso-pharynx, in the former two of which the bacilli have often been found. A previous disposition to tuberculosis is present in many of the cases, viz., tuberculosis elsewhere in the body; recent convalescence from an exanthematous fever; unsuitable food, and bad hygiene; and the most susceptible age, namely, that between the tenth and twenty-fifth years.

Symptoms.—The disease begins with painless enlargement of one or more glands of a single group; or a gland enlarged from previous irritation remains swollen after all apparent cause has been removed. The swelling gradually increases, and involves the other glands of the same group, and of other groups, and may extend to those of the opposite side. The tumours are round, smooth, and elastic to the touch, and at first are movable under the skin and on the underlying structures; and if palpation is made deeply enough, several of the smaller glands can be felt. Sometimes they remain in this condition for a long time, but as a rule the disease progresses without intermission, and gives rise to caseation and softening with signs of fluctuation. They also are subject to attacks of acute or subacute inflammation, with pain and tenderness; and this usually results in *periadenitis*, which causes firm adhesions to the surrounding tissues; in addition, if due to pyogenic infection it ends in suppuration. If destruction of the gland by this means is sufficiently complete, the whole gland may be disintegrated and discharged as pus, and the tubercular process thus checked; but usually it results in a chronic discharging sinus lined with tubercles. As the skin is reached by the tubercular process, it becomes discoloured and breaks down, leaving irregular, undermined edges: and pyogenic infection through the openings is common. Those ulcers leave disfiguring cicatrices on healing. There is little constitutional disturbance in pure glandular tuberculosis; but sometimes there are slight rises of temperature in the evenings, and some anæmia and wasting. Pain, fever, and other "inflammatory" symptoms are due to pyogenic infection.

Diagnosis.—In the early stages, before adhesions have formed, it may be distinguished from non-tubercular enlargement by its persistence after all obvious sources of irritation are removed; from lymphadenoma, by being not so widely disseminated in the axilla, groins, etc.; from lipoma, by its more solid feeling, or in the later stages by fluctuation; and, when there is much adhesion or calcareous infiltration, from sarcoma and carcinoma, by the history of the onset and the age of the patient.

Treatment.—All possible sources of irritation must be removed,—enlarged tonsils, adenoids, decayed teeth, etc. Before adhesions have formed round them the glands can be shelled out through a small incision, and this should be done when possible. If they are confined to the upper part, they may be removed through an incision in the suboccipital region of the scalp (*Dollinger*), where the scar will be concealed by hair; lower down they may be removed by a transverse "collar" incision (*Kocher*), with wide retraction of the wound, the scar falling into the natural folds of the neck. For cosmetic reasons sometimes even these are not permitted in the earlier stages; and the glands may then be injected singly with iodoform emulsion, or solution (1-4) in aniline oil, repeated at intervals of a fortnight. In the latter method (*Gray*) the dose must not exceed 3 minims, or poisoning symptoms, with cyanosis, fluttering pulse, etc. may be brought on. When the gland has liquefied, it may be punctured with a trocar and evacuated before injection. When the surface has broken, the tubercular tissue should be curetted, the diseased skin cut away, and the cavity packed with iodoform gauze; and when the wound has healed, the rest of the glands may be excised with less danger of septic infection. The disease is always more extensive than appears from the surface examination, and a wider incision may be required to clear out all the glands; in which case the skin is incised along the sterno-mastoid, and if necessary a flap may be fashioned by temporarily cutting across that muscle at its upper or lower attachment. If the muscle is much infiltrated and destroyed, it should be included in the mass and removed with it, care being taken not to damage the branches of the spinal accessory nerve to the trapezius. Should the jugular vein be firmly adherent to the glands, it may be ligated above and below, and excised with them. If the wound is not soiled with the contents of burst glands, it may be sutured, with a small drain in the lower part; otherwise it should be filled with iodoform gauze, and closed temporarily with secondary sutures. Constitutional treatment must not be neglected.

Malignant Disease.—The glands may be the seat of primary sarcomata and carcinomata; but more frequently they are subject to invasion secondarily by malignant disease from any of the parts mentioned above. Sometimes the disease appears long after the primary focus has been apparently extirpated, and usually, when once affected, the glands increase rapidly in size, and become firmly fixed to their surroundings by infiltration and inflammatory adhesions.

Thyroid Gland.—Chronic enlargement, or **goitre**, though very common in Switzerland and some other countries, is comparatively rare in this country. It takes several forms,—(*a*) *parenchymatous*, when the whole gland, or part of it, is hypertrophied; (*b*) *adenomatous*, when separate nodules, usually encapsuled, are formed in the normal gland substance; (*c*) *cystic*, when the follicles are distended with colloid secretion, or nodules or haematomas break down. Secondary changes sometimes occur and give rise to *calcified* or *fibrous* goitres. If due to malignant disease it is known as *malignant goitre*; and when the vascular supply is very great, pulsation may be distributed throughout the gland, (*pulsating goitre*). Another form, *exophthalmic goitre* (*Grave's* or *Basedow's disease*), is also characterised by a free blood-supply, but the swelling is probably secondary.

The precise cause is unknown, but is attributed, among other things, to the drinking water, soil, and climate—the first of which appears to have the most direct influence. It is endemic in certain places, and when it occurs rapidly among a number of people situated in the same circumstances it is called "*epidemic*." It is more prevalent in women than men; it begins often about puberty, and the swelling is sometimes more marked at menstrual periods or in pregnancy. When the gland is diseased the secretion becomes disturbed, iodothyrin, the chief constituent in the colloid matter, being often diminished; in extreme cases this causes *cretinism* in infants, and *myxœdema* in adults. In other cases it is increased, and gives rise to symptoms similar to Grave's disease.

Symptoms.—A swelling appears in the position of the gland, consisting of either uniform enlargement of the whole organ, conforming more or less to its shape, or of one lobe only; or (in the adenomatous and cystic forms) of an isolated round tumour, or a collection of such nodules in the substance of the gland. Sometimes it grows as a pendulous mass hanging over the chest; in other cases it may be fixed behind the sternum (*intra-thoracic*), and give rise to extreme pressure effects. The mass, whatever its size or shape, moves with the larynx on swallowing. Goitre may arise also in "accessory thyroids" which are by no means uncommon. Pressure from goitres is exerted chiefly on the trachea, causing kinking, flattening, or constriction, and leading to dyspnœa (which may vary in intensity from an increase of wheezing, to a sudden fit of suffocation); on the veins, causing cyanosis, which is increased by the dyspnœa; on the œsophagus, causing difficulty in swallowing; on the vagus or sympathetic nerves, causing cardiac disturbances, and less commonly inequalities of the pupils, and disordered sweating of the face; on the recurrent laryngeal nerves, causing hoarseness and spasm, or paralysis of the glottis.

Treatment.—*Prophylactic*,—persons with slight swellings of the thyroid gland should avoid living in a place where goitre is known to be endemic, or at least should use water only from a safe source. *General*,—iodine, in the form of iodide of iron internally, and the tincture on the surface, have some effect in reducing the swelling, and should be tried for a time in all cases, without being pressed to the point of disturbing the digestion. *Local*,—often there is no indication for surgical treatment of a small goitre; but if there are pressure symptoms, or evidences of thyroid poisoning, or any steady increase in size, the tumour should be removed. Adenomas and cysts may generally be *enucleated* from the sound gland tissue, by shelling them out of their capsule; bleeding from this operation is usually slight, but it may be profuse. This method insures the maximum of sound tissue being left, though the operation, not being so radical as the others, is liable to be followed by recurrences. Multiple disseminated nodules and cysts, and diffused hypertrophic goitres, with or without cystic degeneration, must be treated by total or partial *extirpation*. A small part of the gland must always be left behind to provide a sufficient amount of thyroid secretion, otherwise the condition of *cachexia strumipriva* (similar to myxœdema, but usually with rapidly fatal results) is produced. The "collar" incision of Kocher is convenient for most goitres, and if the swelling is confined to one lobe it may be limited to that side only; a perpendicular incision downwards may be made at any time, if more room is required. The muscles are retracted, and the gland is loosened from its surroundings at one side, and dislocated forwards. The vessels on that side are tied, and the removal is continued on the other, except for a small piece at the upper or lower pole of one of the lobes. If only half of the gland has to be removed, it is clamped across the isthmus and then divided. Part of a diseased gland may be *resected* and the stump ligated, or crushed with powerful clamps. This is sometimes combined with enucleation (*enucleation-resection*). In some cases, especially when the goitre is situated deeply in the thorax, the only way of removal is by opening its capsule and scooping out its substance (*eventeration*).

The mortality in skilled hands is very low, but there are certain conditions which add greatly to the danger: stenosis of the larynx, with restricted aëration of the blood; disturbances of the circulation through heart weakness or venous obstruction; extensive interference with the thyroid function: severe Grave's disease, with emaciation and tachycardia; and malignant and inflamed goitres. Essential for success are (*a*) strict asepsis, (*b*) free incisions, (*c*) complete ligation of vessels, (*d*) avoidance of damage to muscles and nerves, and (*e*) minimum of anæsthesia (*Kocher*). Many of these operations can be carried out under local anæsthesia alone, without undue pain or even discomfort; but sensitive patients, otherwise sound, may be given a small dose of ether. If much anæsthetic is used respiration is apt to be dangerously embarrassed.

In malignant goitres every piece of the gland must be removed, and the patient afterwards fed with thyroid extract to prevent cachectic conditions. In such cases infiltration of the surroundings is apt to occur early; and the recurrent larnyngeal nerves are specially liable to be involved.

Exophthalmic goitre is a medical disease, characterised by rapid pulse (*tachycardia*), tremors of the limbs and other nervous phenomena, enlargement of the thyroid, and protrusion of the eyeballs (*exophthalmos*). Surgical treatment is sometimes called for, the usual measures being: ligation of the arteries supplying the gland; dislocation of the gland out of its bed, and laying it on the surface of the wound, where it gradually atrophies (*exothyropexy*); or sometimes excision of the superior sympathetic ganglia in the neck. The first of these seems to be as efficient as any. If the gland causes dyspnœa from pressure, it may be safely divided across the isthmus between ligatures.

Œsophagus.

Wounds may occur from cut throat, the passage or penetration of sharp bodies swallowed, or violence in attempts to remove foreign bodies. As a rule small internal wounds heal readily if the œsophagus is kept at rest; but where the wound is deep, and especially if any food or other matter escapes, there will be inflammation in the deeper planes of the neck or in the mediastinum, in the latter case usually with a fatal result. *Rupture* above the cardiac end sometimes happens from severe injuries; it usually causes death from shock. Perforation is apt to occur if the gullet is already affected with cancer or other disease, and here there is always an escape of foul matter.

Treatment.—To prevent the escape of fluids through the opening after wounds, the patient must be fed for the first few days entirely by the rectum. If an abscess forms in the neck it must be opened up and drained.

Scalds and **corrosions** are apt to be caused in children, from drinking boiling water; and among adults, by drinking corrosive liquids, the most common being carbolic acid or vitriol taken in mistake for castor oil. Hot liquids seldom penetrate beyond the pharynx, and act chiefly by setting up œdema of the air passages. Erosion of the gullet, if recovery takes place, is usually followed by extensive and extreme cicatricial contraction.

Treatment consists of relief of shock, soothing applications to the pharynx, and rectal feeding. Complications must be dealt with as they arise.

Foreign bodies of all kinds may stick in the throat, but those with sharp edges, such as tooth-plates, pieces of bone, fishbones, pins, and nails are the commonest. In children, where the œsophagus is never very wide, even smooth bodies like coins and fruit-stones may stick at one of the narrower parts, *i.e.* opposite the cricoid cartilage, the bifurcation of the trachea, and above the cardiac orifice. A sharp-edged body gives rise to a pricking sensation; and this usually persists for a time after it is removed. Large smooth bodies cause discomfort, dull pain, obstruction to swallowing, and a feeling of choking.

Diagnosis is made by the history, by the passage of bougies or olive-tipped probangs, by X-rays for metal and many other solid bodies, and by inspection through the œsophagoscope passed into the gullet with the head well thrown back.

Treatment.—Large smooth bodies in the upper part should be removed with bent œsophageal forceps; or if they are impacted beyond the reach of the forceps, an attempt should be made to get rid of them by tickling the back of the pharynx to encourage vomiting. They may often be helped to pass into the stomach by forcing them gently downwards with a sponge-tipped probang; or in the lower part by slowly passing a narrow conical bougie alongside the body into the stomach, and withdrawing it suddenly, when the foreign body is sometimes jerked downwards. If a sharp body is successfully passed into the stomach, the patient should be fed with thick food in the hope of surrounding the edges with a smooth covering, and allowing it to pass without catching on the mucous folds farther down; purgatives must be avoided, and the fæces should be examined daily to ascertain if it passes. Coins in the throat may be caught with a "coin catcher,"—a flexible rod with a ring hook at the end; this is passed down beyond the coin, and picks it up in the hook on being withdrawn. Sharp objects, such as tooth-plates, may be caught in an "umbrella" probang, furnished with a rosette of bristles which can be expanded and closed at will. By the latter means, however, the œsophagus may be damaged; hence all sharp bodies impacted below the level of the larynx should be sought for by the œsophagoscope and removed through it with long forceps; lately strong forceps have been introduced to enable the surgeon to cut a solid body in pieces and so facilitate its removal. If dangerous symptoms arise from the presence of foreign bodies which resist all attempts at removal by internal methods, an external opening (*œsophagotomy*) should be made in the gullet; the left side of the neck being chosen, where it lies nearer the surface. After the body is extracted the wound in the œsophagus should be closed by Lembert's suture; but the external wound should always be packed with iodoform gauze, and allowed to heal by granulation, as leakage from the œsophagus so often occurs. This operation cannot as yet be carried out with any hope of success in the mediastinum; but foreign bodies blocked at the cardiac end may be reached through the stomach (*gastrotomy*), and removed after gradual dilatation of the orifice. If obstruction is complete and irremediable, a permanent opening into the stomach (*gastrostomy*) must be performed.

Dilatations and **diverticula** are occasionally met with. They may be congenital, and gradually get larger as the patient grows; or they may be due to recurrent efforts to pass food through a narrowed œsophagus; here dilatation takes place at first, and, as this increases, it ends in the formation of a pouch. Another form (in the thoracic part) is due to tubercular glands in the mediastinum, which become adherent to the wall of the œsophagus, and on cicatrising after the disease has subsided, draw out small sacs with them as they contract (*traction diverticula*).

The **symptoms** are a certain amount of difficulty in swallowing, so that the patient takes an unusually long time over an ordinary meal, and may have to hold the head in one position to enable the food to pass; the occasional, but by no means constant, development during meals of a lump in the neck, pressure on which projects the food back into the mouth; regurgitation of food, sometimes in very large quantities, without admixture of gastric juice; retention of food in the throat, which may be recognised after an interval of several days; in some such cases the decomposition which sets in gives rise to intolerable nausea. The commonest situation is the level of the larynx, and the pouches usually arise from the posterior wall. Bougies passed into the throat advance without difficulty for a certain distance, and are then brought to a sudden stop if they enter the pouch; at other times they pass easily into the stomach. The distance from the teeth indicates the locality of the pouch, at least of its fundus. A direct and definite examination may be made with an œsophagoscope.

Treatment.—The diverticulum should be excised by dissecting it out through an external wound in the neck, the sac being previously occupied by a bougie. The wound in the œsophagus should be sutured, but the external wound treated as in ordinary œsophagotomy.

Stricture or **stenosis of the œsophagus** is either spasmodic or organic. The former (*œsophageal spasm*) is met with in hysterical girls. It is diagnosed by the presence of other hysterical symptoms, and by the easy passage of bougies during anaesthesia; and it is treated by anti-hysterical means.

Organic strictures are due to (*a*) simple fibrous cicatricial contraction following corrosion or injury, and in rare cases syphilitic sores; less commonly to (*b*) stenosis from pressure of tumours (enlarged glands, goitres, etc.), aneurysms, abscesses, and bony deformities pressing on the outside; and most frequently of all, (*c*) malignant tumours in the lumen.

(*a*) **Fibrous strictures** occur, as a rule, above one of the narrower parts of the œsophagus, where the irritant fluids are apt to be delayed in their passage downwards, but most frequently at the upper part. They may be annular in shape, but more often tubular, spreading up and down for a considerable distance.

Symptoms.—There is at first difficulty in swallowing solids, while liquids pass easily, though sometimes this is reversed; later it affects everything swallowed. On auscultation at the back, fluids may be heard to trickle past some time after the swallowing movement has ceased. If there is dilatation above the stricture part of the food may be regurgitated. Bougies passed into the throat are arrested at the level of the constriction, and may be held firmly if they penetrate part of the narrow stricture. To ascertain if there are multiple strictures an olivary-headed bougie should be used. The larger sized instruments should be used first, as the smaller ones are apt to be caught in the folds of the mucous membrane. The stricture can generally be directly examined by the œsophagoscope.

Treatment.—Gradual dilatation should be tried at first, with a series of bougies with tapering points; they may be left in for 10-30 minutes at a time. When the stricture is sufficiently dilated, a *Symond's tube* may be inserted and left for a fortnight or so before changing. This consists of a short funnel-shaped tube inserted by means of a flexible bougie, resting with its wider end on the upper part of the stricture; the constant slight pressure on the walls tends to dilate the constriction, while food is allowed to pass through its lumen. A string is attached to its upper end to facilitate its withdrawal. As recurrences are common this treatment should be repeated at intervals. For very tight strictures firm, dry catgut may be passed in, and allowed to swell by absorbing moisture; when one size has expanded enough, a larger size may be inserted in its place. These may be inserted through the œsophagoscope in difficult cases. If the constriction is near the cardiac end, it may be dilated by the finger or other instrument introduced through an opening in the stomach (*retrograde dilatation*). Even with care afterwards there may be troublesome leakage from such gastrotomies, especially if done in two stages. For stenosis in the middle part a heavy shot should be fastened to a string and swallowed, and the end caught through a gastrotomy wound; the string is sawed up and down, and the wall of the stricture is thus partially cut through with little risk of damage (*Abbé's string saw*); a large bougie or Symond's tube should be passed afterwards to maintain the dilatation. This is the only method of *internal œsophagotomy* now recommended for such strictures; and openings in the neck also are given up, as being unnecessarily dangerous and inefficient. In extreme strictures a regular gastrostomy with a good valvular opening gives much the best results; the rest thus given to a contracted œsophagus often results in some retrogression of the obstruction.

(*b*) **External** swellings causing stenosis should be removed if possible; otherwise relief may be given by gastrostomy.

(*c*) **Malignant stricture** is due to epithelioma; and it may be situated in any part of the œsophagus, but most frequently in the middle about the level of the bifurcation of the trachea, and next often at the cardiac end. It is more common in men, and arises generally about the fortieth year and upwards. It may develop in the scar of a simple stricture. The disease begins either as a ring-shaped infiltration of the deeper layers which ultimately ulcerates, or as localised cauliflower growths on one side.

Symptoms are those of fibrous stricture, but nearly always accompanied by pain on swallowing, referred sometimes to the root of the neck, but not necessarily to the seat of the disease. Blood or fragments of cancer may be thrown up; and anæmia and emaciation are often out of proportion to the restriction of diet. Secondary infection of glands is common; and a significant sign of œsophageal cancer is the appearance of a single gland in the supraclavicular fossa without obvious source of irritation. The implication of glands may also produce irritation of the sympathetic, with contraction of the pupil, long before any other nerve shows signs of involvement.

Treatment is purely palliative. In the absence of much ulceration or exuberant excrescence Symond's tube may be worn. Dilatation, or Abbé's method, is usually too dangerous from risk of perforation and escape of foul discharge. In advanced cases the most suitable treatment is gastrostomy.

CHAPTER V.

SURGERY OF THE THORAX.

INJURIES OF THE THORAX.

Contusions of the chest occur from falls, crushes, etc. and their importance depends on the degree of injury to the thoracic contents. Even when there is no fracture of the ribs there may be rupture of the lungs, leading to pneumothorax and emphysema; the latter is especially dangerous when it penetrates the mediastinum, on account of the dyspnœa set up by pressure; the heart or great vessels may be injured; and sometimes there is cyanosis and deep ecchymosis of the head and neck, due probably to general effusion through the walls of the capillaries, without any apparent injury to the lungs or vessels. *Concussion of the chest* from sudden violence produces a condition of collapse, due probably to the action of the cardiac depressors. The main *treatment* is rest in bed, with aspiration of any fluids in the pleural cavity which cause compression of the lungs.

Fractures of ribs are very common, and result from direct violence by falls or blows; or indirectly from crushing the anterior and posterior walls of the chest together; and occasionally from muscular contraction in coughing, or during parturition. The fracture is usually at the middle or posterior part of the bone, and often involves several ribs. The commonest site is about the 5th, 6th, and 7th ribs; those above and below are progressively less liable to fracture—the upper ribs being protected by the clavicle, scapula, and thick muscles, and the lower ones by their mobility. The fracture, which is almost always complete, generally includes rupture of the pleura; and sometimes the intercostal vessels are torn, bleeding from which causes hæmothorax. There is often very little displacement; but if the fragments override much, there is apt to be penetration of the lungs, resulting in hæmoptysis, pneumothorax, or emphysema; with greater displacement the pericardium and heart may be punctured; or the diaphragm penetrated, and the liver, spleen, or stomach wounded.

Ribs unite rapidly (3-4 weeks); and though the callus may at first be considerable on account of the constant movement, it is usually completely absorbed, and all evidence of such injuries may have disappeared in the course of a year or two. (A similar restoration to normal conditions is seen in the new formation of bone in the periosteal tube, after a piece of rib has been removed for draining an empyema.) When more than one rib has been fractured the callus sometimes joins them all together.

Symptoms.—Pain is excited by pressure over the site of the fracture, or by deep breathing. But as tenderness is often due to bruising alone, the ends of the rib should be approximated by pressing in front and behind, so as to bend the bone; pain is elicited at once if the rib is broken, but not if merely bruised. Crepitation and deformity are not usually evident unless more than one rib is fractured, or a rib is broken in more than one place. Friction (from dry pleurisy) can usually be heard on auscultation over the seat of fracture; and if the lung is injured there is often an area of subcutaneous emphysema.

Treatment consists of strapping the affected side, or if that is insufficient, the whole chest, with adhesive plaster, so as to control the movements of the ribs. If a fragment is depressed and pierces the lung no constriction should be used, but the patient should be kept in bed with a narrow pillow between the shoulders. In refractory cases with persistence of serious symptoms, the projecting parts of the fragments should be excised.

Fracture or *separation* of the **costal cartilages** gives rise to symptoms similar to the foregoing. The *treatment* is the same, and union takes place by bone.

Fracture of the sternum is not very common. It is due to direct violence from blows, or to impaction of the chin against it in falls on the head. The fracture is usually transverse, but may be oblique; it is often multiple, and is generally accompanied by other injuries (*e.g.* of the ribs or spine). There is sometimes severe pain, dyspnœa, and cough, with crepitus and overriding of the fragments; but at other times only localised pain and swelling. *Treatment* is that of fractured ribs, and, especially, keeping the patient in bed with a narrow pillow between the shoulders. If displacement of the fragments is not corrected by this means, and gives rise to dangerous symptoms, the fragments should be exposed by an incision and replaced in good position.

Wounds of the chest wall which do not penetrate the pleura call for no special treatment. Those **penetrating the pleura**, however, are dangerous if they involve the lungs, heart, or great vessels; but also from the risk of exposing the pleural cavity to the pressure of the atmosphere (*pneumothorax*), and to infective inflammation (*pleurisy* and *empyema*). The intercostal or internal mammary vessels also may be torn, and fill up the cavity with blood (*hæmothorax*).

Treatment.—The bleeding must be stopped, the external wound cleansed, and the opening closed to prevent further entrance of air. Should the bone be splintered, the cavity may be explored with the finger and loose fragments removed. The patient must be carefully watched to note the onset of pleurisy or pneumonia.

Injuries of the Thoracic Contents.

The lungs may be **contused or ruptured** by compression of the chest. There is pain, coughing, and expectoration of blood-stained mucus. Subsequently a patch of congestion may develop where the injury was greatest; and this may be followed by gangrene or abscess; or the inflammation may spread to the whole lung. As a rule, however, complete recovery takes place.

Wounds of the lung occurring from penetration of broken ribs are generally superficial and give rise to little trouble. Those made with weapons and projectiles are usually dangerous on account of profuse hæmorrhage. If the larger blood-vessels near the root are wounded, sudden death is almost inevitable. In injury of the parenchyma, part of the blood is coughed up (*hæmoptysis*); part fills up the air cells and tubes, and may cause asphyxia; and part enters the pleural cavity (*hæmothorax*); those conditions vary in degree, both absolutely and relatively. Even when the bleeding stops, reactionary and secondary hæmorrhages are not uncommon. In addition, air may escape from the lung into the pleural cavity (*pneumothorax*) or into the connective tissue (*emphysema*). The issue of blood and air as froth from the external wound with a hissing sound is known as *hæmatopnœa*.

Symptoms.—The foregoing signs may be present, and there is usually severe dyspnœa and shock from hæmorrhage. Sometimes nearly all symptoms are absent, and there may be no more than a sense of oppression in the chest, cough, and weakness; at other times progressive dyspnœa appears; or sepsis develops around a foreign body (bullet, piece of cloth, etc.), resulting in gangrene or general inflammation of the lung.

Treatment is confined to rest and quiet, with iced drinks for subduing the distressing thirst; but stimulants and hot drinks should be avoided, and no long transport of the patient should be undertaken. The external wound should be closed after disinfection; and if it is very large, bleeding may sometimes be controlled by firm plugging with gauze or by transfixion-ligature. Foreign bodies should not be sought for by probing except with the finger; and if none can be detected at once, the track in the lung should be packed with iodoform gauze, so that when suppuration takes place the body may be extracted or discharged along the sinus.

Injuries to the pericardium and **heart** occur from penetration of broken ribs, or from stabs or gun shots. Wounds of the heart in most cases are rapidly fatal; but sometimes after injury to the ventricle alone the patient survives. The *symptoms* are severe shock, dyspnœa, and fluttering pulse; and as hæmorrhage into the pericardium continues, pressure and impediment of the heart increases. If it diminishes, evidences of pericarditis will be detected later. Wounds of the auricle or great vessels are generally immediately fatal.

Treatment.—Absolute rest, with morphine to quieten restlessness. If pressure on the heart begins to cause serious impediment to its movements, the fluid should be aspirated from the pericardium; otherwise it should be left, as it tends to control bleeding. In favourable cases an attempt should be made to suture wounds of the ventricle through a wide osteoplastic flap exposing the pericardium.

Wounds of the chest involving the **bronchi, œsophagus,** or **thoracic duct,** usually set up suppuration in the mediastinum, and are generally ultimately fatal.

Complications of thoracic injuries.

1. **External Hæmorrhage.**—From (*a*) an intercostal or internal

mammary artery; (*b*) the lungs; or (*c*) the liver or spleen, through the diaphragm. *Diagnosis*: when the blood comes from the lungs it is bright red, and often churned into froth with air; when from the abdomen, it wells up in a steady flow, and is dark in colour; when from the parietal vessels, it may appear in jets. *Treatment*: an intercostal artery should be ligated, by stripping it off with the periosteum lying along the lower edge of the rib, and catching it with forceps or transfixion ligature. Sometimes it may be controlled by pressure applied by packing a pouch of lint into the opening, filling this with gauze, and pulling on it so that it becomes jammed against the inner side of the ribs. The internal mammary artery may be tied in the intercostal spaces, if necessary after excision of part of the costal cartilages. Bleeding through the diaphragm must be treated from the abdomen.

2. **Hæmothorax** is effusion of blood into the pleural cavity, arising from the same sources as the preceding, but most commonly from penetration of the lung by a fractured rib without an external wound. The *symptoms* are increasing dyspnœa, with absence of pulmonary sounds, and dulness on percussion progressing upwards. There is sometimes pneumothorax in addition, and suppuration often follows. *Treatment*: bleeding is treated where possible as in the foregoing. If accumulation in the pleura threatens suffocation, the fluid should be removed by aspiration; or the chest may be incised and drained; and this must be done if suppuration sets in.

3. **Hæmoptysis,** either from a wound or contusion of the lung, as well as from disease, is recognised by expectoration of frothy blood of a light red colour; or if a large vessel is wounded, by blood of a darker colour welling from the mouth, in which case it is usually fatal. Moderate hæmoptysis generally stops spontaneously. *Treatment*: rest and application of cold to the chest; ice to suck; no stimulants. Adrenalin and other purely local styptics should be avoided.

4. **Pneumothorax** (air in the chest) arises either from an external wound, or by escape of air from the lung, when the parietal and visceral layers of the pleura are not adherent. It causes collapse of the lung—at once if the opening is large, or gradually if small. The lungs naturally dilate on inspiration, and in normal circumstances completely fill out the chest; but as they are unable to distend against atmospheric pressure in pneumothorax, the movements of the collapsed lung are very

slight. If the pleural cavity becomes sealed and no inflammation takes place, the air is gradually absorbed, and the lungs eventually resume their normal position and function. The *symptoms* are dyspnœa, a hollow note on percussion, and absence of respiratory murmur on auscultation. If there is any fluid in the pleural cavity shaking produces succussion. *Treatment*: if dyspnœa becomes alarming the air should be removed with a trocar or aspirator.

5. **Emphysema**, entrance of air into the areolar tissue (called *surgical emphysema*, to distinguish it from an entirely different condition met with in the substance of the lungs), is generally due to penetration of a lung by a broken rib, simultaneously with laceration of the pleural and intercostal tissues, so that air is forced into the pleura during inspiration, and into the subcutaneous tissue during expiration. The more valvular the opening the wider the condition is likely to spread. In most cases it is confined to a small area of the chest wall, but it may cover the whole body from head to foot. It is recognised by the crackling feeling under the fingers, with distension of the skin, so that the contours are altered. Sometimes pressure on the neck may cause embarrassment of breathing. More rarely contusion of the lung may cause air to enter the mediastinum. *Treatment*: immobilisation of the ribs; and if there is much dyspnœa a few punctures may be made in the skin of the neck.

6. **Prolapse of the lung** may occur through a wound in the chest: it should be returned if possible, and the wound closed. If adherent by inflammation, the prolapsed piece may be ligated and cut off. **Hernia of the lung** is prolapse of lung tissue into a distended scar or a thin area of the chest wall. It becomes more prominent on forced expiration, and is often reducible. *Treatment* consists in wearing a protecting truss.

7. **Inflammation** may ensue from direct infection, or by breaking down of a collection of blood in the pleura or pericardium, giving rise to *pleurisy* and *empyema*, or *pericarditis*.

DISEASES OF THE THORAX.

Abnormalities.—The **sternum** is sometimes incompletely developed, and may be distorted, fissured, perforated, or even absent, the defects being replaced by fibrous tissue. One or more **ribs** may be absent at the lower end of the thorax; or an additional rib may be present, attached to the first lumbar vertebra. **Acquired malformations** are due to disease (*vide* Scoliosis, etc.), or from pressure of tools, etc. against the chest.

Inflammatory diseases of the chest walls include pyogenic, tubercular, and syphilitic diseases of the bones and soft tissues.

Subpectoral abscess arises after injuries to the chest, or from infective inflammation of the deep glands beneath the muscles. The *symptoms* are those of acute suppurative fever, but generally of an asthenic type. The local signs are apt to be obscured by the depth of the situation; fluctuation and even œdema are generally absent, but there is usually tenderness on pressure. It is *treated* by incising along the border of the pectoralis major, and removing the pus by Hilton's method. In **tubercular**, and the less common *actinomycotic* disease, cold abscesses often form along the ribs, and in some respects may simulate empyema.

Tumours or hydatid **cysts** may arise in the chest walls; they are treated like similar conditions in other parts.

Intercostal neuralgia (*pleurodynia*) arises from exposure to cold, or from irritation of the nerves by caries of the spine or ribs, or by tumours. It is often accompanied by a band of herpes (*h. zoster*) along the line of the painful nerve. Any removable cause should be treated by medical or surgical means, and in refractory cases the nerve may be resected.

Pleural effusions comprise serous and purulent exudations, from acute or chronic pleurisy, often due to pneumococcic or tubercular infection, but met with in association with other acute diseases. Clear exudation (*hydrothorax*) also arises from œdema, secondary to disease of the heart or kidneys, and from hydatid cysts; and milky fluid (*chylothorax*) from rupture of the thoracic duct. The general treatment of such conditions belongs to the physician. After the presence of fluid in the chest has been determined by dulness on percussion and absence of respiratory murmur, varying with position and progress of the disease, its nature may be determined by plunging an *exploring* syringe with a long needle directly into the chest in the 7th or 8th interspace, generally behind the axillary line; above this level the lung is more apt to be in apposition to the chest wall, and below it the diaphragm generally comes close to the lower ribs. The skin must be previously disinfected, and the needle and syringe should be sterilised by *boiling* before use (hypodermic syringes with leather pistons should never be used for such a purpose, as they cannot be properly disinfected). No anæsthetic need be used; but children should be clasped in their nurse's arms, and held steady, lest the needle breaks off in struggling.

Paracentesis.—If the fluid is *clear* and serous it may be allowed to drain away out of such a needle; but as suction at inspiration may cause entrance of air, and with it microbes into the chest, pneumothorax or a suppurating pleurisy may be set up. For this reason *aspiration* is usually preferred; it is accomplished by puncturing the thorax with a similar but larger needle, or a trocar and canula, attached by means of a tube with air-tight connections to a vacuum-bottle, which is emptied by an air-pump. The fluid should be withdrawn slowly, or troublesome coughing and dyspnœa, or rapid and irregular pulse, and sometimes exudation of blood may be produced. When all or sufficient of the fluid is removed the needle is withdrawn, and the hole immediately closed with collodion. If the fluid indicates a *hydatid* cyst, either in the pleura or lung, it must be removed by excision.

If the fluid is *purulent* aspiration is not enough, and the chest must be incised (**thoracotomy**). This may be done by making an incision along an intercostal space and draining the pleura; but the ribs being in such close apposition to one another, there is rarely sufficient room to explore the cavity, and drainage tubes are apt to be compressed. In most cases, therefore, **resection of rib** is necessary, and this does not add much to the severity of the operation. The patient is placed so that the sound lung is not embarrassed by the weight of the body. Light anaesthesia only should be used, and in many cases local anaesthesia, by Schleich's infiltration or by ether spray, is sufficient. The most suitable place for incision is at the level of the 7th or 8th ribs and behind the axillary line. It is made along the line of the rib down to the bone, the periosteum shelled off in front and behind, the rib cut through with rib-shears, and an opening made through the periosteum and pleura. When the pus has run out, the cavity should be explored with the finger in order to break down adhesions, open up pockets of pus, and remove shreds of fibrin, which are sometimes present in great masses, and which if left tend to delay healing. In foul pleurisies it is advisable to flush out the cavity with warm saline solution, to dilute and remove poisonous products; but irritating antiseptics should not be employed. A large drainage tube the size of the thumb is inserted for a short distance; if the tube is too long, it does not drain well and may cause a pressure sore on the lung. The patient is kept lying on the diseased side to allow the chest to drain by gravitation, and discharge is aided to some extent by coughing. Rise of temperature often indicates a reaccumulation of pus, and the cavity may have to be explored and cleared again. The tube should be removed when discharge becomes small; if left too long it is apt to cause a persistent sinus. To restore expansion of the lung in convalescence, the patient should be directed to blow up an air-cushion daily, and so exert internal pressure; the wound also may be covered with oiled-silk or rubber tissue to act as a valve and prevent further entrance of air.

Most empyemas treated in this way recover, but if there is much adhesion on the surface of the lung, or if the cavity is covered with tubercular granulations, the lung may not expand; there is thus a persistent pneumothorax which continues to discharge pus, and to cause weakness and sometimes hectic fever or amyloid disease. To allow the chest wall to fall in and meet the lung **thoracoplasty** is performed. It consists in loosening or removing the ribs overlying the whole cavity. They may be removed subperiosteally by first excising one rib, and then proceeding to those above and below through the same incision (*Estlander* and others); the soft covering is pressed against the lung and eventually adheres, with the result that the lung often regains some of its expansile power. When the pleura is greatly thickened it should be removed along with the ribs by means of a U-shaped flap-incision (*Schede*). The ribs may also be loosened by cutting them across subcutaneously in front, behind, and in the middle, so that the flaps which result can be bent inwards (*Helferich*). In some cases the lung may be *decorticated* (*Délorme*) by bluntly dissecting off the fibrous covering; this, however, is seldom possible on account of the excessive hæmorrhage. The results of these operations, as of old empyemas, often induce a curvature of the spine, and this should be averted if possible by exercises.

Pneumotomy, incision of the lung, is sometimes indicated for hydatid cysts, localised abscesses of tubercular or actinomycotic origin, bronchiectasis, or foreign bodies. A wide opening is made in the chest wall, preferably with a flap of soft tissues and bones in one piece. If the pleural surfaces are adherent the operation is much safer, and is more easily carried out. If not, the lung must be stitched to the parietes by a continuous circular suture, in order to shut off the cavity from the pulmonary wound. The lung may be incised at once, but if time allows, it is better to wait a few days till adhesions have formed. The incision may be made with a knife, but if there is much congestion a thermo-cautery should be used; this leaves a persistent tract which may be useful for drainage. *Hydatid* cysts should be shelled out if possible; and if this cannot be done completely, the cavity should be packed with gauze.

Pneumectomy is excision of a portion of the lung. It has been done for isolated tumours or localised tubercular foci. The piece to be removed is surrounded and constricted by a ligature passed, if necessary, by means of a large curved blunt needle, or by crushing forceps, and cut off with a knife, scissors, or thermo-cautery.

Prognosis.—Operations on the lungs themselves are always severe, apart from the serious nature of the conditions that call for them; and the mortality from shock or hæmorrhage is very great. The best results have been got in hydatid cysts, and abscesses or gangrene following pneumonia: while in tumours, actinomycosis, tuberculosis or bronchiectasis, prospects of cure or relief by surgical means are very slight.

Pericardial fluids may have to be removed to relieve embarrassing pressure on the heart, or on account of suppuration. *Paracentesis* is performed with a trocar introduced immediately to the left of the sternum. Incision (*pericardotomy*) and drainage are carried out by making a skin flap with its base along the sternum, and removing the 5th and 6th costal cartilages close to it, avoiding the internal mammary artery; the pericardium is exposed, picked up with a forceps, and incised.

Mediastinal abscesses arise from (*a*) wounds; (*b*) from extension of diseases of the sternum or the vertebræ, (*c*) deep-seated suppuration in the neck, or (*d*) abscesses in the lung; from (*e*) breaking down of mediastinal glands which have been affected secondarily to diseases of the head or neck, the lungs, or even the bowels and mesenteric glands; or from (*f*) rupture of the bronchi, œsophagus, or thoracic duct. They may be located in the *anterior* or *posterior* mediastinum.

The **symptoms** in the acute form are those usually associated with suppuration, together with dyspnœa, and severe pain which is generally referred to the shoulder-blades or sternum. In chronic cases the constitutional symptoms are slight, and the chief evidences are those of pressure.

Prognosis is always grave in the acute form; and in the chronic form there is danger of an abscess bursting into the bronchi, and causing death from asphyxia.

Treatment.—If the abscess points at the side of the sternum it should be drained in that situation. Otherwise a free opening should be made *in* the sternum and the mediastinum exposed. If pus has formed it must be let out; if not, the opening will relieve tension, and prevent excessive absorption of toxic products. Care must be taken not to wound the numerous important structures in that region. If the disease is in the posterior mediastinum the opening should be made from behind, by resecting the transverse process of a vertebra and the adjoining piece of rib.

SURGERY OF THE BREAST.

Abnormalities.—*Supernumerary nipples* are sometimes found on the breasts of males or females; and they represent undeveloped mammæ. They usually occur a little below the mamma, or on some part of the lines passing from the shoulders to the pubis through the normal nipple. In other cases the breast is *ill-developed*, and gives rise later to difficulties of suckling. In rare cases the glands and nipple are *absent*, or *infantile* (*micromastia*).

Eczema and **cracks of the nipple** are not uncommon in nursing mothers, as the skin at that part is delicate and easily fissured. They cause severe pain, and usually prevent the breast from being used for suckling. They should be *treated* with soothing ointments, the surface being hardened with astringents, and the painful fissures touched with nitrate of silver. The milk should be drawn off into a feeding bottle with a breast-pump.

Syphilitic sores on the nipple are usually *secondary* condylomata; but a wet-nurse may be infected *primarily* by a syphilitic child. *Treatment* is of the usual antisyphilitic kind, and nursing should be stopped.

Paget's disease of the nipple is a painful, red, and angry-looking excoriation resembling eczema. The ulceration is persistent, there is a discharge of clear yellow fluid, the nipple is often retracted, and the skin puckered. Many cases are followed by cancer of the milk ducts, which afterwards infiltrates the breast tissue. The lymphatic glands are not usually enlarged unless cancer has developed.

Treatment.—If refractory to soothing treatment the breast should be amputated as a precautionary measure, without necessarily removing the glands in the axilla.

Neuralgia of the breast (*mastodynia*) sometimes arises in connection with ovarian disorders. There is no obvious sign of disease, but pain is severe, and radiates along the arms, back, and chest. The *treatment* is general, to improve the health; and sexual disorders are attended to.

Hypertrophy of the breast is a condition that sometimes occurs in girls about puberty. It may develop to an enormous extent, and shows increase afterwards in pregnancy; and the breast may become heavy and pendulous (*prolapse*). In some cases it is due to new-growths. *Treatment*: if of moderate size the breast should be supported by slings; if excessive, it should be amputated.

Mastitis (*inflammation of the breast*), in the **simple** acute form, is not uncommon in women at the menopause, in boys or girls at puberty, and in infants shortly after birth. A similar form is sometimes met with in pregnant and nursing women, due to stagnation of milk, and showing no evidences of infection either by the progress or by examination of the discharge. There is little pain as a rule, but the breast is tender on pressure; and the swelling, though tense and elastic, is moderate in amount; in infants there is often a milky discharge from the nipple.

Treatment.—In ordinary cases, warm fomentations, and (except in infants) belladonna and glycerine, relieve the symptoms and help resolution of the inflammation. If suppuration takes place the pus must be let out at once.

Acute infective mastitis occurs chiefly in nursing mothers, and comes on usually a week or two after confinement. It is favoured by general debilitating causes, by sore nipples, stagnation or excessive secretion of milk, and by lack of cleanliness of the part and the clothing covering it. It arises from (*a*) infective irritation of the sebaceous glands or lymphatics of the areola; (*b*) of the milk ducts (by far the most frequent origin); and (comparatively seldom) from (*c*) metastatic infection from puerperal metritis. The infection, which nearly always ends in suppuration, spreads either along the lymphatics, and sets up inflammation with abscess in the subcutaneous tissue overlying the gland (*supramammary abscess*), or beyond its limits (*paramastitis*); between the lobules of the gland (*interstitial*), or in the loose lymphatic tissue beneath the breast (*submammary*); very frequently it bursts through the intervening walls and invades the lobules and ducts (*parenchymatous*). With infection through the ducts, inflammation is at first limited to one or two lobules, but generally spreads to the adjoining ones, and may permeate the whole gland. In the haematogenous form the infection is more likely to be general throughout the breast from the beginning.

Symptoms.—The general ones are those of acute inflammation. Locally, there is throbbing pain in the breast, especially if the child is allowed to suck. The gland is swollen more or less uniformly, but with diffuse thickening at one point, which is tender on pressure; pus can sometimes be expressed from the nipple. Later, fluctuation can be made out in abscesses of the more superficial parts. In submammary abscesses fluctuation is rare, but the breast is pushed forward as a whole, and there is sometimes œdema at the lower edge, where the abscess tends to point. The axillary glands are generally enlarged and tender.

Treatment.—The breast should be supported with a sling or broad bandage; suckling should be stopped, and belladonna plasters applied to both breasts; and the residual milk should be removed with a breast-pump. Some discharge may occasionally be expressed by gentle massage; but as soon as an abscess is diagnosed, it must be opened at once and drained, and all septa between the loculi should be freely broken down. In parenchymatous and supramammary abscesses the incisions should radiate from the nipple, so as to avoid needless injury to the vessels and ducts; for the same reason a submammary abscess should be opened by an incision round the lower segment of the mamma; and in all they should be sufficiently free and deep to reach all loculi. In some cases the destruction of the breast is so complete, that amputation may be the best treatment.

Chronic mastitis occurs in either of two forms: as a rounded swelling of a segment of the gland, sometimes of considerable size (*chronic lobar mastitis*), or as a diffuse thickening of the lobules (*lobular induration, interstitial mastitis*), giving rise to a bullety feeling on palpation; the latter form is often accompanied by a *cystic* condition. It arises from subsidence of simple acute inflammation; from injuries of various kinds; from pressure of corsets, or habitual leaning against something hard; and sometimes during menstrual disorders, and towards the end of lactation. The age most liable to this affection is that in which cancer begins to be more prevalent, viz., about forty and over. The connective tissue undergoes slow inflammation, and the epithelium of the acini is stimulated to excessive proliferation. As cicatrisation proceeds the ducts are apt to be obliterated, and their contents may be pent up and degenerated (*multiple cystic disease*).

Symptoms.—A swelling is felt in the breast, and pain is sometimes complained of. The swelling in the *lobar* form is confined to one segment, and its limits are not well defined; it is firm and elastic; moves freely with the breast on the chest wall; and in the early stages the skin over it is often, but by no means always, movable. In old cases involvement of the milk ducts may lead to retraction of the nipple. The pain, if present at all, appears mainly on pressure or irritation, or if suppuration occurs; it generally subsides after soothing treatment. In the *interstitial* form the swellings are irregularly diffused throughout the breast, often giving an appearance of general hypertrophy. Fluctuation can rarely be detected in the *cystic* form on account of the smallness of the cysts, which rarely exceed in size that of a pea or a bean. The axillary glands are sometimes enlarged, but are affected more or less uniformly, and are generally fairly movable, and do not cause notable pressure effects on the surroundings even when of great size. In cases of doubt, lest the swelling be cancerous, a piece should be excised for rapid examination; and if it prove to be malignant, the necessary operation should be carried out forthwith.

Diagnosis (*see* Cancer of the Breast).

Treatment.—All sources of irritation must be removed. If there is excoriation of the skin, soothing ointments should be applied; and if there is pain, the breast may be covered with a belladonna plaster. As a rule, a localised swelling should be excised; general enlargement treated by application of potassium iodide ointment: any cysts enlarging to appreciable extent tapped; and if suppuration occurs the abscess should be freely opened. If the swelling increases regularly in spite of precautionary measures, in older patients at all events, the breast should be amputated.

Tubercular disease is recognised to be much more common than was recently supposed; but in the earlier stages it is still liable to be mistaken for simple chronic mastitis. The disease begins in an acinus or its surrounding tissue, and progresses as tubercle does in other situations, eventually breaking down into caseous and purulent collections, or less commonly into hard calcified masses. When suppuration takes place the interlobular septa are usually burst through, and the whole breast is liable to invasion. In favourable cases the pus finds its way to the surface before much of the gland is involved, but in any case there is a tendency to progressive infiltration and destruction. Where the breast is active the milk becomes contaminated with tubercular débris and bacilli, and is apt to infect a suckling child. Tubercular abscesses sometimes develop in the *submammary* tissue, and in symptoms resemble simple abscesses in the same place.

Treatment.—General constitutional treatment is adopted; and if the patient is nursing, suckling must be stopped and the child weaned. Isolated tumours should be excised completely: multiple swellings must be laid open, all septa broken down, and the lining scraped out. If the breast is much destroyed it should be amputated.

Syphilis of the breast, though not infrequent in the nipple, is rare in the gland itself. Gummata sometimes occur, and may be mistaken for cancerous tumours.

Tumours occurring in the breast are of great importance, as the majority of them are malignant. The simple tumours comprise *fibromata*, rare in the pure form, and certain other connective tissue tumours (*lipoma*, *myxoma*, etc.), still more rare. Much more common are the *adenomata* combined with other elements, and giving rise to the tumours known as *fibro-adenoma*, *myxo-adenoma*, etc. *Sarcomata* of different kinds are met with, but are comparatively scarce, while *endothelioma* is very rare. *Carcinoma* of *acinous* form is very common, that of the *ducts* less so, while squamous-celled *epithelioma* is rather rare. *Cysts* also occur, originating either from retention, or by degeneration of simple or malignant tumours.

Fibro-adenoma is the commonest benign tumour in the breast. It arises as an adenoma, or proliferation of epithelial cells and increase of acini, surrounded by fibrous tissue; (or possibly as a fibrous tumour enclosing glandular acini, *adeno-fibroma*). Two varieties are recognised microscopically; in one of which, the commonest, the acini form small clusters imbedded in a considerable amount of fibrous tissue; in the other they are of a more tubular shape, and are dilated at intervals to form cysts (*cysto-adenoma*), into which project outgrowths of fibrous tissue covered with epithelium. In neither case is the basement membrane encroached upon by the epithelial cells. The tissue outside the acini is either well-formed fibrous tissue; or it is soft and gelatinous (*myxo-adenoma*): or in other cases it is composed of elementary connective tissue resembling sarcomatous cells. (This is sometimes spoken of as "*adeno-sarcoma*"; though it has neither the clinical features nor the tendency to recurrence of a sarcoma.)

Symptoms.—Adenomata occur in young and healthy women, chiefly between the ages of 25 and 35, and most frequently in those who have borne children. The swelling is round, clearly defined, and sometimes multiple, firm and elastic, but not hard. The skin over it is movable, and not dimpled; and the nipple is not retracted by pulling on the tumour. Pain is absent as a rule, but there may be neuralgia or discomfort. The axillary glands are not affected; and there is no cachexia from the presence of the tumour alone. On examination after removal the tumour is elastic, convex on section, and pinkish-white in colour. In the fibrous form it shows a more or less foliated appearance; in the softer varieties there are areas of sago-like material, and (in the cystic form) branching cavities filled with clear fluid, unless there has been hæmorrhage, when it will be brown and turbid.

Progress is slow and regular, though sometimes an increase in size may be noticed at menstrual periods; and there is no tendency to spread to the lymphatic glands, or to form metastatic growths.

Treatment.—The tumour should be enucleated. In order to avoid leaving an unsightly scar, it may be exposed by making a curved incision round the lower or outer segment of the breast, turning up the flap so made, and shelling out the swelling.

Sarcomata of the breast are met with in young women usually before the age of thirty. The tumours are generally *round-celled* sarcomas, but sometimes of the slightly less malignant *spindle-celled* variety. As a rule there is no increase of gland tissue; and, unless some of the acini become enclosed in the mass, they form no part of the new-growth. They occur as rounded tumours which grow with great rapidity, and encroach on the adjoining structures; and they are often surrounded by a more or less fibrous capsule, which, however, really forms part of the tumour. They are firm and elastic, but not of the stony hardness of scirrhus; and there is little tendency to dimpling of the skin. The axillary glands are not usually enlarged till late in the disease: but metastatic growths by hæmatogenous infection occur early. The progress, as in sarcomas elsewhere, is towards breaking down, with ulceration, sloughing, and often severe hæmorrhage.

Diagnosis.—They are to be distinguished from simple adenomas by their rapid growth; from cysts, by the absence of fluctuation; and from these and other swellings, in all cases of doubt, by section after removal.

Treatment consists of early amputation of the breast, with complete removal of the capsule also; if the lymphatic glands are involved the axilla must be cleared out.

Cancer.—*Carcinoma*, in one or other form, is the commonest tumour occurring in the breast. It develops in women about the period when the mamma undergoes involution, viz. from 45 years onwards: it may occur before that time, but is more frequent as age advances. It occurs also occasionally in the male breast. No special relationships with injury, lactation, or pregnancy have been established, but doubtless these are predisposing causes. The ordinary **acinous** form (*spheroidal-celled carcinoma*) begins in one of the lobules; the cells quickly push their way through the basement membrane: invade the lymphatic vessels, filling them out, and displacing or destroying the structures in the immediate vicinity: and penetrate other segments of the breast, and the fatty tissue beyond its limits.

Signs.—The breast is examined by placing the hand flat on it, pressing gently against the chest wall, and moving the fingers in all directions, so that all irregularities and tuberosities, especially at the edges, may be felt. If the gland is picked up between the fingers, even a normal breast gives the sensation of a tumour, where it is bent on itself, and errors can easily be made in this way. The tumour occurs usually as a hard nodular swelling **(scirrhus)** of moderate size, spreading rapidly once it begins to grow, but rarely attaining to great dimensions on account of the constant tendency to cicatricial contraction in the central parts. The skin over it is adherent at an early stage, and later becomes pitted like pig-skin, or dimpled into folds, by contraction of the fibrous bands joining the breast and skin (*Cooper's suspensory ligaments*). The tumour itself soon becomes fixed to the pectoral fascia and muscle by penetration of cancerous fibres along the lymphatics; this can be detected by raising the arms till they are horizontal, and moving the breast on the muscle in the direction of its fibres: if adhesions have formed, movements in this direction are impossible or very much restricted. If the tumour is situated near the centre of the breast the milk ducts become involved, and draw on the nipple, causing retraction; if at the periphery, this happens only in the later stages. There is rarely any discharge from the nipple in this form of cancer. The axillary glands become invaded, and may be felt as hard, separate, and movable lumps, slightly larger than the normal glands; and the lymphatic vessels leading to them can sometimes be felt rolling under the fingers. These enlargements may not be detected, however, for some months after invasion has occurred. There is usually stabbing pain from an early period, either in the breast itself or referred to the back; though in some cases there is absolutely none until the disease is well advanced. Cachexia is an important factor; it is characterised by loss of weight, apparently irrespective of want of appetite and consequent reduced feeding; there is also anaemia, and sometimes yellowing or browning of the skin. These conditions become aggravated if the tumour breaks down and gives rise to septic intoxication.

Progress.—The younger and better nourished the patient, the more rapid, apparently, is the growth and the larger the size attained, though this is by no means constant. In some cases the progress is so rapid that the condition is spoken of as "*acute cancer*." In aged and wizened women with "poor health" the tumour sometimes grows so slowly, and cicatrisation keeps pace so well with it, that it shows signs of atrophy more than of growth (*atrophic cancer*); and it is said that spontaneous cure sometimes results in this way. As the skin becomes involved it breaks down and leaves an ulcer, with irregular, everted edges, discharging a sanious fluid, or if septic, foul pus. In some cases the subcutaneous tissue becomes widely infiltrated, and from the ramifications of this extension outgrowths spread towards the surface along the strands of Cooper's ligaments, and give rise to numerous nodules in the skin (“*cancer en cuirasse*”). In rare cases the infection spreads across the lymphatic plexus to the other side of the body, and may affect the glands of the opposite axilla, sometimes without implicating the other breast on its way. In the downward direction it may spread to the external layers of the rectus muscle and the linea alba, and from there infect the subperitoneal tissue and abdomen: it may even follow the falciform ligament, and so invade the liver. The disease spreads directly inwards, and, as has been said, affects the pectoral fascia and muscle; it also follows the lymphatics along the perforating branches of the intercostal and internal mammary vessels, and thus invades the pleura or mediastinum. From the axillary lymphatics the infection may spread to the subclavicular and supraclavicular glands, and even those of the neck. Meanwhile adhesions are apt to form around the axillary glands, and cause compression of the blood-vessels (especially the veins) and the nerves, giving rise to extreme œdema and pain of the arm. When the disease has lasted some time (6 to 24 months) *metastatic* tumours are apt to develop in the lungs, liver, and bones (especially the sternum, the ribs, the humerus, and the femur), probably through the blood stream.

On section the tumour gives a creaking or grating sound to the knife; in the central parts it is of the consistence of an unripe pear, and greyish white in colour, but at the growing edges it is soft and pinkish; the cut surface becomes concave in shape; and a milky juice, exuding from the ducts, may be scraped off, and shows on microscopical examination granular débris, cells, and free nuclei.

Varieties.—**Cystic carcinoma** is uncommon except in rapidly growing tumours. It has the same structure as ordinary scirrhus, but there are islets of tissue broken down into cysts, either from degeneration or from hæmorrhages. Cancer may also develop in the walls of a pre-existing simple cyst (*carcinomatous cyst*).

Medullary ("*encephaloid*") **carcinoma** is much less common than scirrhus. It forms a soft, unencapsuled swelling, growing rapidly to a considerable size, with early invasion of the glands, implication of the skin, and deposit of metastatic growths in the lungs and liver.

Colloid cancer is a rare form in the breast. It is characterised by a more bossy appearance, less retraction and dimpling of the skin, and more definite limitation of its boundaries. Growth is usually slower than in scirrhus.

Tubular (*columnar-celled*) **carcinoma,—duct cancer,**—occurs somewhat rarely as soft, rounded, painless tumours, usually multiple, implanted in the breast near the nipple. They generally consist of cysts of the milk ducts, into which papillomatous masses project, and eventually burst through and invade the tissues beyond. The nipple is not retracted; but a discharge of blood-stained fluid is characteristic. Growth is slow, and the lymphatic glands are not affected till late; the skin is not puckered, but may be encroached upon, when it becomes dusky red, and ultimately ulcerates. Metastatic growths are rare.

Epithelioma (*squamous-celled*) grows from the surface of the nipple or areola, usually in old people; and is generally preceded by Paget's disease, or some other form of eczema. [It is considered by some that Paget's disease is cancerous from the beginning; and that the "eczema" is due to weeping of the surface of the epithelioma.] It penetrates to the breast tissue, and from there to the lymphatic glands and elsewhere. There is usually pain or a burning sensation at the nipple, and lancinating twinges in the breast. It is slightly less malignant than scirrhus.

Diagnosis is easy when the disease is far advanced and the features well marked; but in the early stages, when radical treatment is so essential, a cancerous tumour may be confused with inflammatory and other benign swellings. In *chronic inflammatory thickening* the skin may be pitted, and the tumour fixed in the breast, and ill-defined; but the whole gland is often uniformly enlarged, scars of old abscesses may be visible, and the glands are swollen at an earlier stage, and to greater size than in cancerous conditions. *Adenomas* are generally clearly limited and freely movable; there is no dimpling of the skin, and the lymphatic glands are not enlarged. *Tense cysts*, when fluctuation cannot be elicited, are similar in most of their symptoms to adenomas, and differ from "malignant cysts" by the absence of adhesions or extension of the disease to lymphatics. *Sarcomas* are more rapid in growth and soon involve the skin, and do not affect the glands in the early stages. *Duct cancers* are apt to be multiple, are more circumscribed, and are specially distinguished from scirrhus by the bloody discharge from the nipple; they differ also from simple papilliferous cysts of the ducts by the tumour invading the breast. *Epithelioma* of the areola or nipple differs from eczema in its intractability to soothing treatment; and from scirrhus in its superficial and more localised situation, at all events in the early stages.

In cases of *doubtful* diagnosis it is advisable to prepare for a radical extirpation of the disease; but first to incise the tumour and *remove a piece* from the growing edge for immediate examination. This may be readily carried out by soaking the piece in a solution of gum, and freezing it on to the table of a portable microtome, such as *Cathcart's*. A good number of sections are rapidly cut, and at once placed in water, where they are rinsed by means of a handled needle; from that they are transferred to a quick-staining fluid, and again rinsed in water. The most likely section is picked out, mounted in glycerine on a slide, and examined under a microscope. No attempt is made at producing fine or even very thin specimens, the main object being to determine the disposition of the epithelial layers in carcinoma, and the shape and relation of the cells in sarcoma. Should the disease prove to be malignant the incision is covered with a collodion dressing, the skin again disinfected, and the radical operation proceeded with. The knife previously used is of course discarded. If it is benign, the tumour may be removed through the original incision, which should, if possible, be planned with that object in view.

Prognosis.—*Scirrhus* cancer of the breast untreated by operation usually proves fatal in from two to three years; *medullary* cancer in from six to twelve months; while the malignancy of *atrophic* scirrhus and *duct cancer* is comparatively small Death occurs from exhaustion due to cancerous cachexia or sepsis, or from secondary invasion of vital organs. Metastatic growths in the bones are apt to cause spontaneous fractures; and tumours in the spinal cord and nerves cause agonising pain. When scirrhus is extirpated early, along with all its probable extensions, the prognosis is fairly good; about 50 per cent of the patients remaining free from the disease for three years. In those cases, too, if recurrences take place, death more frequently takes place from internal tumours affecting vital organs; and painful discharging sores are less likely to develop.

Treatment, in all operable cases of cancer, is removal of the breast and a zone of connective tissue for some distance around it. In *atrophic scirrhus*, and in *duct cancer* and *epithelioma* in the early stages, this is considered sufficient, since lymphatic extension is slow. All other methods of treatment—by drugs, X-rays, or caustics—are generally useless; they may do great harm, and in any case cause delay while there is yet hope of cure by extirpation. In *scirrhus* the removal must include the nipple and breast with all its probable extensions; the skin around the tumour for a circle of from four to six inches in radius, according to its appearance; the fat and other subcutaneous tissue over the whole side of the chest, from the clavicle to the costal margins, and from the sternum to the scapula; the fat, lymphatic vessels, and glands along the axillary vessels and beneath the pectorals and latissimus dorsi; the pectoral fascia, and in most cases the pectoralis major muscle, except its clavicular portion.

The incision is more or less circular, and may be made lozenge-shaped in order to give a good suture line. The skin is dissected from the underlying fat, the subcutaneous tissue of the chest walls, and the pectoral muscle, breast, and connective tissue are cut away in one piece. The separation is continued up to the axillary glands, which are removed along with the fat and connective tissue, so that a clean dissection of the axilla and chest walls is left. The spaces beneath the pectoralis minor and latissimus dorsi are examined for glandular enlargements. If the axillary vein is densely adherent it may be cut between two ligatures and taken away with the tumour. The skin flaps are sutured together, if necessary, with the aid of relaxing incisions to allow them to be approximated; if they do not then meet, the bare surface is afterwards grafted. The wound is drained by a tube inserted into the axilla through a small incision in front of the latissimus dorsi; the axilla is padded to prevent sagging of the skin, and the dressing applied. The arm is extended at right angles to the body, and kept on a pillow in that position till the wound heals; in this way cicatricial contraction is obviated to a great extent. Movements of the arm should be begun as soon as the skin is healed.

Some surgeons object that removal of the pectoral muscle causes unnecessary disablement; but patients in whom it has been excised have generally almost full movements of the arm, and are often less troubled by cicatricial adhesions than those whose fascia alone has been removed.

If there is doubt as to the limits of the cancerous extension, valuable information may be got in a few minutes by *Stiles's* method of examining the mass removed. It is first washed to cleanse it from blood, then soaked for five minutes in nitric acid (5 per cent) solution, and again washed. On examination of the cut surface fat appears dirty yellow, fascia and fibrous tissue gelatinous, and nodules of disease (masses of cells) as white points.

Recurrences arise commonly in the scar or in the subcutaneous tissue near it; but often in the glands if these are not completely removed at the operation. They are caused probably by some of the malignant cells being left in the tissues, and growing to form a new tumour. Sometimes these remain quiescent for a long time (in some cases for as many as thirty years), before secondary growths appear; but as a rule recurrences take place within one year.

Treatment.—Isolated nodules in the scar or under the skin should be excised along with a wide margin of healthy tissue: when the surroundings or the base are found to be cancerous, however, the operation will be of no avail. Recurrences in the axilla should be excised whenever that is possible, in order to avert pressure on the vessels later. Some tumours recur again and again without spreading very far; these should, of course, be excised as soon as they are detected. Metastatic tumours of hæmatogenous growth should be left alone.

Inoperable cancers are those in which radical extirpation cannot be carried out. Amongst them, apart from those which are obviously too extensive for removal, are classed, (*a*) *cancer en cuirasse*, because the disease is always much more extensive than the limits of the skin nodules indicate; (*b*) cases with symptoms of internal metastatic growths; (*c*) those cases in which the glands in the neck have been involved, as by that time internal growths have most likely taken place;

(*d*) cancers which are adherent to the thoracic parietes; (*e*) cancers secondary to growths elsewhere.

Treatment in these cases is confined to subduing pain and sepsis (*vide* p. 69). In certain cases the swelling has been diminished and the general condition ameliorated by *oöphorectomy* (*Beatson*), even in women past the menopause. This is said to be aided by administering *thyroid* extract. Some patients certainly improve, temporarily at least; but the majority do not seem to benefit much by this treatment. When pressure on the axillary vessels and nerves is so great that œdema and pain become excessive, the arm may have to be amputated at the shoulder.

Cysts.—A. Retention cysts, (1) *galactoceles*, or collections of milk in obstructed and dilated milk ducts, the milk being generally curdled and forming masses of cheesy material and whey; (2) *serous* cysts attending *involution* of the breast (sometimes cancer arises in the walls, and gives rise to *cancerous cysts*); (3) *papilliferous* cysts, occurring in the ducts just behind the nipple, and containing brownish or blood-stained fluid, and partly or completely filled with branching papillomata, which grow from the epithelial lining. Clinically they resemble duct cancers in their discharging this fluid from the nipple; but the tumour does not invade the breast stroma. B. New-formation cysts. (1) *Inflammatory* (multilocular) cysts distributed throughout the breast; (2) *dermoid* and *hydatid* cysts, very rare; (3) *carcinomatous* cysts, (*a*) from growth of cancer in the walls of a simple cyst; or (*b*) from *colloid* degeneration of a carcinoma, into cysts containing glairy material; or (*c*) from degeneration of haemorrhages or isolated areas of tumour into more or less serous cysts; (4) *sarcomatous* cysts, from myxomatous degeneration of a sarcoma.

Treatment.—Isolated simple cysts should be excised, or, if this cannot be done, opened and packed, and allowed to heal by granulation. For multiple cysts and those of malignant origin the whole breast should be amputated.

CHAPTER VI.

SURGERY OF THE ABDOMEN.

ABDOMINAL WALL.

Contusions of the abdomen, especially if sharp or sudden, may cause injury to the abdominal walls or the internal organs, or profound shock from irritation of the solar plexus. The more brittle viscera—the liver, the kidneys, the spleen (especially when hypertrophied from malaria), and the distended bladder—are liable to rupture. But all the viscera are protected partly by their mobility and elasticity, and partly by the rapid contraction and rigidity of the abdominal muscles under reflex stimulation, so as to form an unyielding shield over them. This condition is induced involuntarily, for instance when a blow is aimed at the belly; and it occurs notably in peritonitis, by irritation of the peritoneal terminal nerves setting up contractions in the muscles supplied by muscular branches of the corresponding spinal nerves. In the abdominal wall the injury may give rise to a hæmatoma, which sometimes undergoes suppuration; or to rupture of the rectus muscle, which, if not successfully treated, may afterwards be the seat of a ventral hernia.

Symptoms.—There is usually considerable shock, severe pain in the abdomen, and vomiting, and sometimes local signs of bruising. Injuries of the viscera produce other signs which will be considered later. *Prognosis* in uncomplicated cases is good.

Treatment.—Shock must be treated first of all, as in other conditions; pain is relieved by warm fomentations, and opium if necessary; and the muscles are relaxed by placing pillows under the knees in order to flex the thighs. Careful examination must be made to determine if a viscus is damaged; if so, laparotomy, performed as soon as shock has passed off, is safer than delay for special symptoms to appear. Haematomas, or abscesses of the abdominal walls, are treated as in other situations. Rupture of the rectus abdominis usually heals by keeping the body bent; if not, the sheath may be opened, and the ends approximated by suture.

Accidental wounds of the abdomen are dangerous if they penetrate the peritoneum, and especially so if any of the viscera are injured as well. Non-penetrating wounds should be cleansed, and sutured in all cases where there is not much contamination; otherwise the scars of such a wound, if deep and not united by first intention, are liable to stretch from constantly recurring pressure, and to lead to ventral hernia. Wounds which penetrate the peritoneum, if small and uncontaminated, should be cleansed and sutured, and a careful watch kept in case peritonitis develops. Large or dirty wounds should be freely opened up, and the interior examined, especially in cases where there is doubt of a foreign body remaining in the abdominal cavity, or of any injury to the viscera. Should omentum or bowel protrude they must be cleansed with warm saline solution, and *if uninjured*, returned to the cavity. Wounds penetrating both the pleural and abdominal cavities by way of the diaphragm must be treated by attending to the thoracic wound, to prevent the entrance of air, blood, or septic infection, and, if necessity arises for treatment of visceral injuries, by laparotomy.

Diseases of the Abdominal Wall.

Inflammatory.—A dangerous form of **cellulitis** sometimes extends from the perineum as a result of extravasation of urine, especially when septic; it spreads rapidly, and causes extensive sloughing and severe toxic symptoms. It is treated by free incisions wherever it appears to be spreading.

Abscesses in the parietes arise from hæmorrhages, rupture of muscles, or wounds; and cold abscesses from tubercular disease. They may also form in the *retro-peritoneal tissues*; the most notable being perinephritic, less commonly pancreatic abscesses, and occasionally abscesses of appendicular origin.

Certain fistulæ are met with in the abdominal wall. (1) **Gastric** fistula arising from operations or wounds involving the abdominal wall as well as the stomach. If there is no obstruction in the œsophagus it may be closed by separating the stomach from the abdominal wall, resecting the thickened tissues around the orifice, and closing this with Lembert's suture, the abdominal wound being freshened and sutured in layers.

(2) **Biliary** fistula results from operation, but occasionally from rupture of an abscess of the gall-bladder (purulent cholecystitis) (*vide* Diseases of Liver).

(3) **Fæcal** fistula often results from bursting of an abscess, with necrosis of part of the intestinal wall, more especially in the region of the appendix; occasionally a fistula is left after an operation for temporary relief of intestinal obstruction.

(4) **Umbilical** fistulæ persist congenitally, from partial, or occasionally complete, nonclosure of (*a*) the *vitelline duct*, or (*b*) the *urachus*. In the former there may be direct communication with the ileum, when the fistula discharges feculent mucus or even liquid fæces; in the latter there is communication with the bladder, and urine is discharged. In most cases, however, the opening is a short sinus which discharges only enough fluid to keep the navel moist, and encourage the growth of bacteria, thus acting sometimes as a dangerous source of infection for abdominal wounds. Those two defects may become closed at the external orifice, and by the accumulation of secretion give rise to *vitelline* or *urachal cysts*. *Treatment* in most cases is not required, but short sinuses may be touched with a thermo-cautery, to encourage adhesions and so effect a cure. Large ones, if they give trouble, must be dissected out, and the opening into the intestine or bladder closed by Lembert's suture. The cysts are removed in the same way.

Various **tumours** arise in the abdominal wall or umbilicus, none of which are of special significance.

Subperitoneal lipomas ("*fatty hernias*") are small collections of fat which penetrate the linea alba from the subperitoneal tissue. They arise from accumulation of fat in the connective tissue accompanying the penetrating nerves and vessels at this point. If they grow to considerable size the openings in the fascia become widened, and "*epigastric hernias*" of bowel may take place in the mass of fat. Such hernias are usually accompanied by persistent pains and a tendency to vomit, due to pressure and irritation on the intercostal terminal nerves, and reflexly through their communicating branches to the phrenics.

Phantom tumour is a term applied to a lump which sometimes appears in the abdominal wall, due to spasmodic contraction of the rectus abdominis muscle. It is met with in women, especially those of a "hysterical" tendency. It may be easily mistaken for a real tumour, if this possible nature is not borne in mind. It disappears under full anæsthesia, and usually reappears as the patient recovers consciousness.

The **abdomen** is sometimes **pendulous** from constant pressure on relaxed walls; it is met with in very fat women, especially those who have borne many children. If great disablement is caused by it a section of the wall may be taken away, and the wound closed by careful suture in layers.

Laparotomy (more correctly *cœliotomy*) or *abdominal section*. In *preparing* the patient, the bowels are cleared by laxatives and enemata for several days before, if time allows, in order to avoid distress from accumulation of fæces in the days succeeding the operation, when no movements are allowed. In operations on the alimentary tract, it is recommended that the patient should be fed entirely on sterilised food and drink before the operation, in order to diminish the putrefactive germs in the alimentary canal. The stomach should be emptied, and if necessary washed out, especially if that organ is to be opened. The bladder must be evacuated immediately before the operation. The skin is prepared in the usual way; but special attention must be paid in cleaning out all crevices in the umbilicus with turpentine and spirit; if it is at all eczematous, it should be filled with tincture of iodine for five minutes, and then rinsed out with alcohol to remove the irritating germicide. Should there be suppuration or discharge from it, or from any sinus, and the wound be in the immediate neighbourhood, the whole umbilicus or sinus should be excised at the beginning of the operation. The patient must be kept specially warm; and, as exposure of the bowels to cold air leads to considerable shock, the room should be kept at about 70° F. If a general anæsthetic is used, ether should be given for preference, as it is less depressing than chloroform.

The line of incision is of importance: it should be planned (*a*) to give the best access to the part desired; (*b*) to do the least damage to the abdominal wall, and avoid leaving a weak spot where a ventral hernia might form; and (*c*) to exclude the umbilicus, a sinus, or an ulcer from the line of incision, lest sepsis should arise from them. Incisions for exploring the stomach, and liver, are made in the epigastric, and hypochondriac, regions; for the appendix, and sigmoid flexure, in the iliac regions; and for the pelvic organs, in the hypogastric region. To prevent the escape of bowels, incisions should be made *at first* only large enough to admit the fingers or hand. In order to adapt them for indefinite prolongation, if the necessity arises, they should be planned so as to avoid cutting across the deep nerves supplying the abdominal muscles, especially the rectus. Those nerves (the anterior branches of the last five or six intercostals, and the ilio-hypogastric and ilio-inguinal) run mainly in the intermuscular planes; in the upper part of the abdomen they are nearly parallel to the costal margin, and in the lower part to Poupart's ligament, while the intermediate ones spread out fan-wise, and are more or less transverse. Any incision, therefore, except in the middle line, should follow those directions as much as possible; transverse curved incisions may be made at any level without being likely to do damage. As the nerves approach the middle line they become more exclusively cutaneous, and end as such in the linea alba; perpendicular incisions in this line, therefore, are harmless in that respect. But the linea alba is poorly nourished, and scars are apt to stretch and give rise to ventral hernias, so that this incision is never recommended nowadays, except for making rapid exploratory examinations in emergencies, or for draining purulent fluid, which otherwise might penetrate the intermuscular planes and set up diffuse cellulitis. Median incisions should in any case avoid the umbilicus by passing round it to the left. The more satisfactory perpendicular incision is one about an inch to the right or left of the middle line (*paramedian*), opening the anterior sheath of the rectus: that muscle is separated at its *inner* (median) and under side and retracted well outwards: the posterior sheath and subjacent layers are then opened about one inch or so from the linea alba (*Malgaigne*, *Lennander*). Those various incisions do not all coincide, and the tendency to hernia formation is thus very small. If the muscle is loosened at its *outer* edge (*Battle*, *Kammerer*) some of its nerves are almost sure to be destroyed, and paralysis and degeneration may result; and this often occurs also in the inner half of the muscle if it is split down the middle. Some surgeons prefer the transverse incision, as they believe the scar to be stronger in spite of the necessary suture of the rectus muscle. In the flanks, the skin and superficial fascia being incised, the muscles are opened layer by layer by separating the fibres with a blunt instrument, and retracting the edges perpendicularly to the direction of their fibres. In closing the wound, the muscles fall together and form a "gridiron" arrangement of scars.

Those processes may be carried out under local anaesthesia, if a general anaesthetic is feared, as in cases of persistent vomiting from intestinal obstruction; but manipulations of the deepest (subperitoneal) layers are extremely painful, and a whiff of ether should be given to cause temporary analgesia during the opening or closure of this part.

In closing abdominal wounds the peritoneum should always be picked up with forceps and sutured separately (or at least along with the transversalis fascia only), in order to prevent it from forming a funnel, and so encouraging development of a hernia. The aponeurotic layers (such as the sheaths of the rectus, the aponeurosis of the external oblique, and the conjoined tendons) should be sutured with strong material which is not absorbed for at least three weeks (thick chromic gut, reindeer tendon, or silk). The muscles may be sutured with catgut to give them a "set" and prevent their being separated during the healing process: but the sutures must be lightly tied, or they will obstruct the vascular supply of the edges, and give rise to atrophy. The skin may be closed with silk-worm or chromic gut; and in all cases where there is a thick layer of fat, a running stitch should be buried in it, to prevent the formation of "dead spaces."

After-treatment in general is discussed on page 83. In abdominal cases the patient should be kept in a quiet and darkened room till the effects of the anaesthesia pass off. Pain, if excessive, may be subdued by morphine or hyoscine. Local pain from dragging on the stitches (due to vomiting and retching) may be controlled by a firm bandage or binder, or by strips of plaster. Vomiting, too, is often relieved by giving sips of hot water, which probably acts by diluting the chloroform or ether excreted into the stomach, and removing it on being expelled. In operations on the stomach or intestines, especially the former, no food should be given by the mouth for three days, in order to avoid exciting the secretion of digestive juices, and so damaging the suture lines. An exception to this rule is made in cases of gastrostomy performed for imminent starvation, and in patients who are very emaciated and weak. Enemas of peptonised milk (two ounces, along with two ounces of saline) are the most useful for rectal alimentation. Thirst may be diminished by large enemas of saline (ten to twenty ounces), which are usually retained if injected slowly enough. In operations which do not involve the alimentary canal fluid diet may be given the second day. This should not be continued too long, as the abeyance of salivary secretion thus induced tends to encourage parotitis, etc. Solid food, therefore, should be commenced as soon as possible. In cases of peritonitis or intestinal obstruction the diet must be entirely fluid. Patients are often unable to pass urine for a day or two after operation, and it should be drawn off thrice daily. There is often an accumulation of gas in the lower bowel: and if this causes distress, a tube may be introduced into the anus, and left for an hour or two to drain off the flatus. The bowels should be moved in six or seven days by a glycerine suppository or an enema, and should be kept regularly opened by laxatives. The stitches need not be removed for three weeks; and the patient should be kept in bed for at least that time, to enable the deep tissues to become firmly united. In certain cases, especially after gastro-enterostomy, where position is of importance for good functional results, the patient may be propped up with pillows. This is of use also in threatened congestion of the lungs.

Complications of Laparotomy.

(1) *Shock* is very common, and is increased by prolonged narcosis, chilling of the body, and exposure of the abdominal contents to cold or to irritant fluids.

(2) *Hæmorrhage*, (*a*) *reactionary*, from slipping of ligatures, or dilatation of previously closed vessels: (*b*) *secondary*, after onset of infection; (*c*) *gastric or intestinal exudation*, appearing as brownish vomit, or tarry motions, and due probably to thrombosis of veins; this may occur even if the alimentary canal is not injured.

(3) *Peritonitis*, commencing with rising temperature, dry skin, and, especially, increasing pulse-rate. Slight pyrexia, falling after 24 hours or so, and unaccompanied with rapid pulse, is common after most laparotomies.

(4) *Pneumonia, or broncho-pneumonia*, is more common after abdominal operations than others, except those on the

respiratory tract. It may be due to aspiration of septic particles, or to diminished movements of the thorax on account of abdominal pain, or to pulmonary embolism.

(5) *Intestinal obstruction* (*ileus*), due to peritonitis, or to adhesions or displacements with kinking of the bowel. Mild atony usually appears after laparotomy, but generally passes off in a day or two.

(6) *Suppuration of the abdominal wound*, which ultimately may lead to a weakened cicatrix, and the formation of a ventral hernia.

PERITONEUM.

The **peritoneum** is a very elastic connective tissue membrane, covered on its inner surface with a layer of epithelial cells, communicating intimately with the lymphatic system; the lymphatics are specially numerous on the diaphragmatic surface, from which they run to the thoracic duct. Absorption, therefore, takes place very rapidly from the peritoneal cavity, and in this way a considerable amount of toxic or even of infective material can be dealt with. The parietal peritoneum is extremely sensitive to pain, being supplied by the branches of the abdominal nerves, which break up into numerous end-organs in the subperitoneal tissue. The visceral layers, on the other hand,—on the mesenteries and omentum, the stomach and intestines, the kidneys, gall-bladder, and anterior surface of the liver, and the serous surface of the bladder,—being supplied entirely by the sympathetic nerves, are wholly insensible to pain, touch, heat or cold; and the acutely inflamed membrane is as insensitive as the healthy. Pain, therefore, is only felt when the posterior wall is dragged on by the mesentery, or when inflammation is set up, either in the retroperitoneal lymphatics and glands, or by direct contact of an inflamed viscus with the abdominal wall (Lennander). Any two layers of peritoneum, if sufficiently irritated by mechanical agencies, exposure to cold or dry air, antiseptics, or toxic exudations, become rapidly agglutinated together, and very soon connected by fully-developed cicatricial tissue. Movements of the intestines drag on these adhesions, and they frequently become drawn out into fibrous cords, and sometimes entirely disappear by absorption.

Injuries of the peritoneum alone are rare, but the visceral layers may be stripped off or torn in crushes of the bowel (especially if previously damaged by inflammation or congestion). There is little or no sign of disturbance, and the rent closes quickly if not infected. Tears of the mesentery may lead to internal hernias.

Peritonitis arises, apart from traumatic causes, from infection through an external wound, or (in women) through the Fallopian tube, or from rupture of an abscess; or more commonly by extravasation of the contents of the alimentary canal, or by simple exudation if any part of it is strangulated or acutely inflamed. The most common direct agent is the bacillus coli, which is found in nearly all cases of perforative peritonitis, with or without streptococci or staphylococci in addition, and sometimes other organisms which are probably accidentally present. In pelvic peritonitis following puerperal sepsis, streptococci are often found in pure culture: and gonococci are sometimes found when it follows gonorrhœa in the female. In rare cases of hæmatogenous origin, especially in children, pneumococci alone may be found. The immediate results of a *localised* and mild infection are rapid absorption of the products, hyperæmia, and adhesion of contiguous surfaces. If the process continues pus becomes formed, and an abscess develops between the surfaces, but shut off by the surrounding adhesions from the general peritoneal cavity. Should the inflammation be more violent, or a bowel wall burst, the poisonous material is distributed over all the surfaces and into all the crevices of the peritoneal cavity, partly by gravitation and partly by peristaltic movements of the bowel; and *generalised peritonitis* is the result. Mild irritation causes increased effusion of peritoneal fluid; but severe irritation quickly interferes with normal secretion, and the surfaces become covered with fibrinous flakes, which diminish their power of absorption; while highly virulent material is sometimes absorbed in such quantities that death results before any reactive exudation can take place.

Symptoms.—General peritonitis usually commences with chill and nausea. Pain comes on at once with a sharp stab if a bowel ruptures: but less suddenly if a localised abscess discharges into the general peritoneal cavity. It is sometimes so severe as to cause profound shock; and it is partly from this circumstance that opium, by diminishing it, relieves the depressing symptoms, and so gives rise to fallacious signs of improvement. The pain is generally referred to a point a little above the umbilicus ("pit of the stomach"); if the irritation starts from the stomach or appendix it may be referred to the epigastric or iliac regions; but such localisation is inconstant and often deceptive. Palpation elicits or aggravates the pain; and, in order to diminish movements of the belly, respiration is shallow and chiefly costal, and the abdominal muscles are held rigid: while the knees are bent in order to try and relax the walls and so relieve internal tension. The face is anxious-looking, pinched, and often cyanosed; the eyes are sunken, and the cheeks flushed. The tongue is coated, and the bowels are constipated and distended with gas (*tympanites*) from reflex paralysis; there is strong aversion to food, but great thirst. The skin is dry, and the urine scanty; the bladder also is sometimes irritable, and micturition is then either painful or impossible. The pulse is weak and thready, and always rapid: it increases in rate as the conditions get worse: and being less influenced by drugs and external agencies, is one of the more reliable indicators of the progress of the disease. The temperature is high with localised abscess; but with diffused suppuration or severe poisoning from rupture of a visens, it is subnormal. Leucocytosis is not usually present except when pus is forming, and its absence is no indication of a favourable case. Paralysis of the bowels gives rise also to persistent vomiting with nausea; the vomit being at first the stomach contents, later bile, and sour or foul brownish fluid, and lastly feculent material regurgitated from the intestine. This is often accompanied by distressing hiccup. The mind is unimpaired, until toxic absorption gives rise to muttering delirium. Locally, diffused exudation is revealed by dulness in the flanks, shifting as the position of the patient is changed.

Diagnosis.—The pain, collapse, and vomiting occurring in peritonitis may be simulated by other diseases: (*a*) *uræmia*, in which the cerebral symptoms are more prominent, the urine is usually suppressed, and always contains albumen: (*b*) *acute enteritis* (or diseases complicated by it), in which diarrhœa is more frequent, rapid pulse less common, and abdominal rigidity usually absent; (*c*) passage of a *calculus* along the *bile-ducts*, or the *ureters*, the pain being more intense over the stone, beginning suddenly, and ceasing as abruptly if the stone escapes, and unaccompanied by distension of the bowels or general tenderness on pressure; (*d*) *contusions* of the abdomen; (*e*) internal *hæmorrhage* ; and especially (*f*) *intestinal obstruction* before the onset of peritonitis, in which the area of tenderness is confined to the point of obstruction, the rigidity of the muscles is less, and cramp-like spasms come on spontaneously, often accompanied by gurgling and visible peristaltic contractions.

Prognosis.—Diffuse septic peritonitis is generally fatal once it is fully established : though in rare cases it takes on a more chronic form, and may be cured by dealing with the separate abscesses. In perforative cases, if operation is performed within a few hours, and provided the effusion material is not too virulent, and more especially if the hollow viscera are nearly empty, prognosis is more favourable.

Treatment.—*Expectant* : in the early stages before there is clear evidence whether the inflammation is diffuse or localised, the patient should be kept lying perfectly still on his back. In cases of threatened peritonitis, in which no definite symptoms have been established, and where the patient is not ejecting everything from the stomach, an attack may sometimes be warded off by administering drachm doses of magnesium sulphate every hour, to induce watery motions, and so deplete the intestinal and peritoneal vessels. Feeding should be entirely by the rectum ; and the distressing thirst may be relieved with enemas (8-16 ounces), or subcutaneous infusions of saline solution, or with sips of very hot water or chips of ice if they do not induce sickness. Dilatation of the stomach and vomiting may sometimes be relieved by washing out the stomach. Ether, oil of camphor, or strychnine may be given hypodermically as stimulating agents. Pain is alleviated slightly by warm fomentations or ice-bags ; if a hypnotic is required morphine should be used by hypodermic injection. Improvements following morphine, however, are very fallacious and usually temporary ; therefore the dose should not be repeated until the effects of the first one have passed off, and the condition has been noted. Nevertheless, there is no object in withholding such a specific for severe pain, *once diagnosis is made* of a condition undergoing spontaneous improvement, or requiring operation. Morphine is sometimes of use also to control peristalsis, and so diminish the spread of infection ; but it also diminishes the powers of absorption of the peritoneum.

Operative : when the inflammation is obviously diffuse, the only hope of successful treatment is by opening the abdomen ;

closing any perforation, relieving strangulation, and removing any gangrenous bowel; flushing out the cavity with large quantities of hot saline solution until the fluid returns clear, and draining the cavity through large tubes in the original wound, or if desired in openings made in the iliac regions. If the bowels are greatly distended they may be drawn out and punctured or evacuated by Paul's tubes. When the infection is due to streptococci, anti-streptococcic serum should be injected. If the patient survives, the process may become more chronic and the suppuration localised into separate abscesses.

It should be remembered that drainage in this way, either for suppuration or any other exudation, has only a temporary value, as adhesions develop rapidly between the coils of bowel round any foreign body, so that the actual cavities drained by a tube soon become very small, and the orifices of the tube blocked. If the tube is inserted in a deep part where the discharge cannot flow out by gravity, it must be filled with strips of gauze, frequently renewed, in order to obtain capillary drainage.

Localised peritonitis arises from infection originally of a mild character, or such as results from gradual leakage through a minute opening in the bowel; or by attenuation of a virulent infection, and limitation of the process by adhesions. The most common forms are *perityphlitis*, due to disease of the appendix; *pelvic peritonitis* in women, from disease of the genital organs: *subhepatic abscess*, following inflammation of the gall-bladder; *subphrenic* and others, from leakage of a gastric ulcer; and abscess in the *lesser omentum*, from pancreatitis, or ulcer in the posterior wall of the stomach.

The **symptoms** often begin as those of general peritonitis; but after a time, if an abscess forms, or if a diffuse case becomes localised, the signs become altered, and in general take on more of the characters of acute suppuration, with pain and tenderness at the site of the abscess, dulness on percussion, and rigidity of the muscles overlying the part. The abscess may burst into the general peritoneal cavity, and then set up diffuse peritonitis, or into the bowel, bladder, or vagina, or (exceptionally) through the skin, with relief of symptoms, and sometimes spontaneous cure.

Treatment.—The abscess, wherever it forms, must be opened and drained. Care must be taken not to break down protective adhesions; and if the general peritoneum has to be traversed to reach the abscess, it must be packed round with gauze compresses. These should be free from loose threads at their edges, and have a tape attached to them for hanging out of the wound, to obviate their being lost in the abdomen (an accident which otherwise can easily occur); and, for this purpose at least, they should be moistened with saline, in order to prevent virulent fluid from soaking through.

Deep-lying abscesses cannot be properly drained by tubes alone. In most cases it is better to fill the cavity with sterile or antiseptic gauze, in the middle of which a tube may be inserted to allow of escape of any fluid in excess of the capacity of the tampon. As strips of gauze readily stick to the bowel surface by penetration of granulations, their removal causes bleeding. To prevent this *Mikulicz's* method of drainage is often used. A large square napkin of gauze with a thread attached to its middle is picked up with a forceps at this point, and invaginated to form a pouch with the string in the inside. It is inserted into the depths of the cavity, and strips of gauze are then packed inside it in all directions. From the pouch they may easily be removed and renewed, as they are not in direct contact with the abscess walls. The pouch itself is withdrawn after a few days by pulling on the string, which turns it inside out from the bottom. Such pouches may be made also of *Renton's* "protective" (*i.e.* muslin soaked in gelatine and treated with mercuric chloride, in order to make it partially insoluble); those made of oiled silk do not admit of free enough drainage. If there are clear grounds for suspecting that a second abscess is lying deeper, the first must be emptied, wiped out, and packed round with gauze, when adhesions may be broken down in the direction of the supposed abscess. When there is a doubt of its presence it should, if possible, be approached through another skin incision, which can be closed if no abscess is found, without the general peritoneum being infected. In most cases of doubt it is wise to await symptoms of continued fever, etc. before making a further search. The wound should be kept freely open, but the ends may be sutured to avoid prolapse of the viscera; and secondary sutures may be inserted, for closing the wound as it fills up with granulations.

Subphrenic abscess is suppuration localised under the arch of the diaphragm, and shut off from the general peritoneum by adhesions of omentum and colon. It arises most frequently after leakage from ulcers of the stomach, but also from those of the colon (and in these cases it often contains gas); or from rupture of a suppurating gall-bladder or a splenic or hepatic abscess. Less commonly, it is due to extension of a perityphlitic or perinephritic abscess; and even of pleural or mediastinal suppuration.

The **symptoms** may be at first very indefinite, but there are constitutional signs of deep suppuration. The liver is displaced downwards, and the diaphragm upwards; these displacements, however, are not always evident clinically. There is often some inflammation of the pleura, or even of the lungs, either from extension of suppuration or from lymphatic absorption.

Diagnosis, from abscess in the liver, or in the lesser omental sac, and from empyema, and basal pleuro-pneumonia.

Treatment.—If the abscess points well forwards it should be opened under the costal margin. If it is situated more to the back, and especially if suppurating pleurisy is diagnosed to be present in addition, it should be opened through a *transpleural incision.* A piece of the 9th or 10th, or both, ribs, is excised; and if there is pus in the chest, it is of course drained. Otherwise, if the two serous layers of the pleura are not adherent, they are made so by stitching the diaphragmatic layer to the edge of the wound with a circular suture. If this is impossible, the edges of the wound are packed round with compresses, and the opening into the diaphragm made in the middle. The edges of the diaphragmatic opening also are sewed to the external wound. The cavity is drained by tubes, and if necessary a counter-opening is made posteriorly.

Perigastric abscess (or abscess in the *lesser omental sac*) arises either secondarily to abscess of the pancreas, or from an ulcer on the posterior wall of the stomach. It may be opened by an incision in front, with precautionary suture of the omentum to the abdominal wound; or through an incision behind, in the costo-vertebral angle.

Chronic peritonitis occurs in two forms, *exudative* and *adhesive.* In the first there is an increase of the peritoneal fluid, which distends the abdomen, and may cause pressure symptoms on the viscera. Apart from tuberculosis the cause is uncertain; but it has been attributed to injury and exposure to cold. *Prognosis* on the whole is good. It is *treated* generally by the physician with mercurial or other inunctions; and only if there is oppression is it necessary to remove the excess of fluid.

The *adhesive* form occurs either by the subsidence of an acute attack, or as a secondary manifestation of obscure inflammation of the abdominal organs. The *symptoms* vary with the situation and extent of the disease. Adhesions on the alimentary canal produce colicky pain, and a certain amount of obstruction, which may at any moment become acute and cause strangulation. In the pelvis they may cause displacements and functional disturbances of the pelvic organs. *Treatment*: though many adhesions atrophy and may completely disappear in time, surgical interference is sometimes called for to relieve pain or obstructions.

Sometimes laparotomy has been performed for tumours of doubtful origin, and, on opening the abdomen, large *masses of inflammatory material* have been found, which have the appearance of cancerous growths. Although not excised, these also may disappear in time after the operation; and from this fact, it is probable that some of the cases recorded of spontaneous cure of cancer have been really of this simple nature.

Tuberculosis (*tubercular peritonitis*) occurs either as part of a general (miliary) dissemination, or as a tubercular infection confined chiefly to the peritoneum; it is common in children. It is rarely met with as a primary affection, but is usually preceded by tuberculosis of the mesenteric lymphatics, following infection through the intestines, or still more commonly the lungs, with or without actual lesions of those organs. Clinically it is recognised in three forms: (1) *exudative*, in which there is an abundant secretion of serous fluid; (2) *adhesive*, in which there are numerous fibrous adhesions, and nodular tumours in the omentum and mesentery; and (3) *ulcerative*, in which the abdomen is crowded with purulent and caseous masses, formed by breaking down of glands and ulcers, and sometimes complicated with communications between the adjacent loops of bowel.

Symptoms.—The chief are progressive cachexia and wasting. Local symptoms are often slight, but there may be vomiting and pains from adhesions, with alternating constipation and diarrhœa, and embarrassment of the circulation from pressure of the excessive fluid. Examination of the abdomen shows, in (1), distension with free fluid, sometimes so great that the skin is stretched and glazed: occasionally the fluid is localised by adhesions: in (2), hard or soft movable lumps scattered throughout the depths of the abdominal organs (*i.e.* enlarged glands and tubercular nodules —"*tabes mesenterica*"); and in (3), immovable doughy masses with areas of fluctuation, and usually accompanied by fever. Tuberculosis around the vermiform appendix, or Fallopian tubes, may give rise to symptoms and appearances of simple perityphlitis or parametritis. If tubercular ulcers of the bowel give way, the result is generally acute perforative peritonitis.

Diagnosis.—The first form, from simple ascites, or that due to malignant disease, and from cysts; the second, from simple and malignant tumours, from appendicitis or parametritis, and from various sorts of intestinal obstruction; the third, from wasting diseases complicated with accumulation of faecal masses in the bowels.

Treatment as a rule is undertaken by the physician. The *serous* form, however, is very amenable to surgical treatment. The abdomen is opened, the fluid allowed to run out, and the wound closed without drainage. The fluid may reaccumulate to a certain extent, but it is generally absorbed again, at least after a second operation. The *modus operandi* is still uncertain; neither rubbing, flushing, nor application of iodoform seems to give any better results. Paracentesis alone, or even the injection of sterilised air, do not have the good effects of a free opening; and possibly the beneficial result may be due to light. In the *adhesive* form simple laparotomy has no special effect; but adhesions may be divided, and isolated nodules extirpated. Tubercular appendices and Fallopian tubes should be removed. In the *ulcerative* forms no good results ensue, except from the evacuation of purulent collections. Further, any operation is dangerous on account of the soft and friable condition of the bowel walls, and the frequency of adhesions between them and the abdominal parietes at the point of incision.

Ascites is a collection of fluid in the abdomen unconnected with inflammation. It is due to obstruction of the general venous system, arising from cardiac or pulmonary disease; or of the portal system, arising from thrombosis or cirrhosis of the liver; or to general hydraemia, from renal disease or other cachexias. An inflammatory form of ascites arises from chronic simple, or tubercular peritonitis; and another form in connection with the presence of cystic or cancerous tumours disseminated over the peritoneum.

Treatment.—When the fluid becomes oppressive by its excess, it may be tapped (*paracentesis abdominis*), with trocar and canula, under the usual strict aseptic precautions. The favourite locality is in the linea alba, between the umbilicus and the pubes, the point being chosen after examination by percussion to show that there is no bowel adherent at the spot. A fine size of trocar should be used, in order to avoid draining the fluid too quickly, and so causing faintness: and with the same object a binder may be applied round the belly, and tightened as evacuation progresses.

Omentopexy.—Cases of ascites, due to portal obstruction, may be relieved by establishing a new avenue of venous return by the method of *Morison* and *Talma*; in which the omentum is attached to the abdominal parietes by suture, or more efficiently, according to later improvements, by stripping up the peritoneum at the left side of the wound, and suturing the omentum in the pocket so formed. The immediate and remote results are fairly good, and the danger of the operation not excessive.

Tumours.—Simple tumours, *fibromas*, *lipomas*, and *myxomas*, sometimes grow from the subserous tissues, especially at the root of the mesentery, mesocolon, or the omentum. They cause symptoms by pressure or traction on the neighbouring organs. They should be excised, if damage to the blood-vessels supplying the overlying parts can be avoided without difficulty.

Malignant disease of the peritoneum is rare as a primary condition; but secondary involvement is common as a result of a tumour of one of the abdominal organs breaking down. It is found as scattered nodules implanted over the whole peritoneal surface, and is generally accompanied by great exudation of serous fluid.

Treatment.—Temporary relief may be given by paracentesis; but the fluid rapidly reaccumulates, and the operation has to be repeated at progressively shorter periods, until the patient is carried off by exhaustion due to the cancerous cachexia.

Benign cysts of the mesentery and omentum comprise *serous-*, *blood-*, and *chylous-cysts*, forming tense rounded tumours near the umbilicus. *Papillomatous cysts* may be disseminated over the peritoneum, from rupture of a papilliferous tumour of the ovary. They seem to hold an intermediate position between simple and malignant tumours, but do not form metastatic growths elsewhere. *Hydatid cysts* are apt to be implanted over the peritoneal surface if a primary cyst of the liver bursts. *Teratoid cysts* are rare, but may occasionally be met with. *Retroperitoneal cysts* may be formed from the remains of the Wolffian and Müllerian ducts.

Thrombosis of mesenteric veins occurs after injuries (bruises or constrictions), or from extension of inflammatory process from the peritoneum, or from embolism. The result is infarctive congestion and stagnation of a wedge-shaped piece of mesentery and the bowel attached to it. If the thrombosis is complete and prolonged the bowel becomes necrosed. In thrombosis limited to a narrow area, the chief danger is from inward spread of the process, especially if the thrombus is "infected." It may invade the portal system, and lead to infarction or sepsis of the liver; or the pulmonary system, setting up pneumonia; or it may spread to the vessels of the lower limb, and set up phlebitis.

INTERNAL ORGANS.

Injuries of the internal organs from contusions or wounds give rise to severe hæmorrhage, or to peritonitis, or both, according to the organ affected. The chief signs of **abdominal hæmorrhage** are pain and shock, with some rigidity of the abdominal muscles, due partly to the irritation of the blood itself, especially clots. The limbs, face, and tongue are cold and pale, respiration is frequent and sighing, and the patient is restless and anxious. The pulse is thready and rapid (120 to 150 per minute), and becomes progressively worse. It becomes slower and fuller after saline solution is injected intravenously or infused; but this improvement passes off, and each succeeding injection elicits less response. The temperature is subnormal, but in the absence of a quick and thready pulse this is sometimes to be attributed to shock alone. The signs of **peritonitis** have already been indicated, the most prominent in these cases being progressive tympanites and rigidity of the muscles.

Rupture of mesentery or omentum gives rise to symptoms of internal hæmorrhage, usually without any localising signs. *Rupture of* **stomach or intestine**—either from *injury or disease*—causes sharp pain, proportional more or less to the amount and virulence of the extravasation; and shock, due partly to the violence and partly to hæmorrhage. There is usually escape of gas, which distends the abdomen, and by separating the abdominal wall from the liver may abolish the liver dulness. The general initial signs of peritonitis are present, and, if operation is not soon undertaken, they become established. Fluid extravasations and exudations are evidenced by dulness on percussion in the flanks, increasing slowly but steadily, and shifting their level on turning the patient. *In injury to the stomach wall* there is generally hæmatemesis; and the pain is localised chiefly in the epigastrium, but often referred to the interscapular region of the back. *In injuries of the intestines* the pain may be general or referred to the locality; and there is often melæna, but as this only appears after 10 to 40 hours, it is valueless for early diagnosis. *Rupture of the* **liver or spleen** produces collapse and other signs of hæmorrhage. The right lobe of the liver is more exposed to injury, hence the blood usually gravitates to the right hypochondriac and iliac regions; while that from the spleen is usually found in the left side; in either case dulness may be obscured by fat or tympanites, or the chief deposit of blood may be in the pelvis. *Rupture of the* **kidney** also causes hæmorrhage, often very profuse; the blood is effused into the perinephritic tissue, and a large hæmatoma is formed, covered with peritoneum; or if that layer is ruptured, it spreads into the general peritoneal cavity, gravitating first into the flank of the affected side. In addition, urine is extravasated into the bloody effusion, and increases the tendency to decomposition. Blood appears in the urine in considerable quantities, except when the ureter or pelvis is torn away from the rest of the kidney. In injuries of these parts of the kidney, too, the pain is often severe, and may be referred to the back, loins, penis, or testicle; while injury of the parenchyma alone is usually painless (Lennander). *In rupture of the* **bladder** the patient passes either a small quantity of urine tinged with blood, or none at all, and if a catheter is inserted the bladder is found to be empty. This is an important sign when it is known that the patient has not passed water for some hours before. There is also pain in the belly and dulness on percussion, especially if the patient is turned on one side; further, there is usually injury to the pelvic bones in addition. *Rupture of the* **gall-bladder** causes sharp pain in the region of the liver; and if there is cholecystitis, peritonitis, localised at first, comes on. If the bile is aseptic the inflammation may be a simple one, and soon subside. *Rupture of the* **gravid uterus** causes collapse. If the fœtus escapes, it appears as a mobile mass in the abdomen; the feeling of resistance on vaginal palpation disappears; and a hard rounded tumour is felt in the pelvis, produced by the contracting uterus, accompanied usually with labour pains and discharge of blood from the os. *Rupture of a* **tubal pregnancy** causes collapse, some pain in the pelvis, and other signs of hæmorrhage. In both of these the history of pregnancy is important, but it is not always available. *Rupture of a* **cyst**, if aseptic, causes shock and pain; absorption from a hydatid cyst usually gives rise to urticaria. *Rupture of an* **abscess** sets up peritonitis.

Treatment.—The shock must be treated first: if hæmorrhage continues, or if rupture of a hollow viscus is suspected, the abdomen must be opened, and the bleeding stopped, or the rupture closed. *In all cases of doubt* the rule is to operate without delay. Saline infusion may be commenced at once if the patient is much collapsed; and ether should be used for anæsthesia in preference to chloroform, as being less depressing. If there is no indication of any particular organ being injured, a small exploratory incision is made near the middle line below the umbilicus. If blood appears, with no visible bleeding point, the wound may be enlarged with scissors, and the abdominal organs systematically examined, beginning with the omentum, bowels, and mesentery immediately under the wound; and the examination continued into the right iliac and hypochondriac regions, across the epigastrium, and down the other side. The pelvis may be examined more easily and thoroughly by elevating it with pillows, or by a special arrangement of the table (*Trendelenburg's position*), so that the bowels fall towards the diaphragm. Perforation of the alimentary canal is evidenced usually by the escape of gas or fluid with a feculent odour.

Ruptures of the *stomach* must be closed with Lembert's suture. If a rupture is not found in the anterior surface, or if a wound penetrates both walls of the stomach, the posterior surface must be exposed and examined by turning up the omentum and transverse colon, and making an opening in the transverse mesocolon; or by making an incision in the anterior wall, and examining the posterior wall from the inside. Small punctures of the *intestines* may be obliterated by a "purse-string" suture; but larger ones should be sutured transversely to the line of the bowel, in order to prevent subsequent stricture. If there is much laceration of the bowel, or if the mesentery is widely detached, gangrene is apt to occur, and it is safer to resect the portion and unite undamaged structure only. Fissures of the *liver* should be closed by deep mattress sutures of thick chromic gut; and to prevent their tearing out, they may be threaded through plates of magnesium, which are ultimately absorbed (*Payr*). Otherwise, wounds in the liver should be packed with gauze tampons. The *spleen*, on account of its extreme vascularity, does not bear suture; and if lacerated, it must be excised, after ligation of its pedicle. When this condition is diagnosed before operation, the opening may be made in the left side along the margin of the ribs. Ruptures of the *kidney* should be sutured if possible: but if the laceration is too extensive, or the ureter torn away, the organ should be excised. If the lesion is diagnosed to be entirely extraperitoneal, a lumbar incision may be made from the middle of the twelfth rib, reaching downwards and forwards towards the iliac crest; but a very free exposure is necessary in these cases. If there is intraperitoneal haemorrhage the incision must be made in front. After such an injury blood-clots are apt to accumulate in the bladder, and give rise to "irritation"; if they cannot be broken up with a lithotrite and evacuated, it may be necessary to perform suprapubic cystotomy. Extravasation from a ruptured *bladder* may be extraperitoneal only, so the incision must be made immediately above the pubes. If urine escapes from the space of Retzius, careful note must be made of all the circumstances to determine if there is intraperitoneal effusion as well; should this be so, the incision is carried into the peritoneal cavity. In such cases Trendelenburg's position should not be adopted until the urine is sponged out of the pelvis, and the bowels packed off with compresses; after which the wound should be well retracted, and the pelvis carefully inspected. The rent in the bladder is sutured in two stages: the first through all the layers except the mucous membrane, and the second through the outer layers and the peritoneum by Lembert's method. Sutures penetrating the mucous layer are apt to become encrusted with phosphates, and should therefore be avoided. The external wound should be drained for some days. If the bladder is much lacerated, the edge of its opening should be sutured to that of the abdominal wall, and a large drainage tube inserted.

Rupture of the gravid *uterus* may be fatal from haemorrhage in a very short time; accordingly, the abdomen must be opened at once, the fœtus extracted, and the uterus in most cases extirpated above the vagina, with ligation of the vessels by means of a handled needle. Small ruptures or wounds may be sutured with stout chromic gut; but abortion usually results in spite of this treatment. In ruptured *extra-uterine gestations* the pedicle (the tube, broad ligament, etc.) must be clamped and tied, and the lacerated structures cut away. If the ovary is involved as much of it as possible must be left. When there are adhesions to the bowels they must be separated: and if the surface continues to bleed it must be tamponed, and the wound left unclosed.

Examination of the alimentary canal is carried out by:—

Inspection.—Prominent dilatation of the stomach and colon, or swellings, may be readily seen in the absence of obesity; vermicular contractions also are sometimes visible, and indicate strong spasmodic peristalsis in order to overcome some obstruction.

Palpation.—The body should be recumbent, the shoulders raised, and the thighs bent on the body to a right angle in order to relax the muscles, while the patient breathes quietly and deeply. In some cases reflex rigidity can only be overcome by general narcosis.

Percussion, either alone or combined with *auscultation*, is useful for making out the limits of hollow and solid organs where they come in contact. It should be carried out lightly, and the results marked on the skin with a pencil. The stomach may be examined in this way, first empty, then filled with water through a soft tube, and then dilated with air. This latter method should be performed by injecting air with a hand-bellows: effervescing fluids are not sufficiently under control, and may do damage. In the same way the rectum and part of the colon may be examined, but less information is gained by this means than in the case of the stomach.

Siphonage of the stomach is now always used in place of the stomach pump for examinations of the gastric contents. For accurate examination the stomach should be first washed out with plain water; a *test meal* of tea and bread and butter is given, and removed with the siphon after 1, 2, 4, or 12 hours, for observation of the progress of digestion and of the presence of free hydrochloric acid.

X-rays are useful to reveal opaque foreign bodies, or the outlines of the stomach when distended with a solution of bismuth. *Gastroscopes* and *diaphanoscopes*, for examination of the stomach, have as yet little value. *Proctoscopes*, for direct viewing of the rectum and part of the sigmoid, are very useful.

Operations on the Alimentary Canal in General.

Preparation.—The stomach should, if possible, be *emptied* by the siphon and washed out before all operations on the viscus, in order to diminish the risk of contaminating the peritoneum with its contents which are always "septic." For the same reason the lower bowel should be emptied by repeated enemas and laxatives. The small intestine may sometimes be emptied by saline purges; this is impossible, however, in cases of obstruction. If, therefore, there is much distension, the gas and foul contents should be allowed to escape by **enterotomy.** The coil of bowel is brought well out of the wound and surrounded with compresses; an incision is made into it longitudinally, and the foul matter allowed to flow into a large compress. When sufficient relief is attained the wound is sutured by Lembert's method. It is often tedious waiting for complete relief, and for this reason, and more especially for the prevention of soiling the wound or peritoneum, *Paul's tube* (a curved glass tube with a flange at each end) is inserted into a small opening in the bowel, and fixed there by a circular suture. The gas and fluid escape through a thin rubber tube attached to the other end, and flow into a pail during the operation; on the completion of which the tube is removed, and the opening into the bowel closed.

Sutures of the stomach or intestine should always be made in two layers; the first including the mucous membrane, and the second the peritoneum and muscular layer only. If the mucous membrane is not sutured the edges are apt to retract, and infective material from the lumen may penetrate its walls, and there set up inflammation and gangrene, leading to perforation or hæmorrhage, or more commonly to thrombosis of the mesenteric vessels, and possibly giving rise to embolic inflammation elsewhere (*e.g.* in the lungs). The outer (peritoneal) surfaces must be turned in so as to cover the other suture (*Dupuytren's and Lembert's sutures*). This double layer is known as *Czerny-Lembert suture.* A mattress suture may be made by

Lembert's method, with a loop at one side of the incision and the free ends tied at the other (*Halstead's suture*). The intestinal wall must sometimes be sutured in a double layer from the inside (as in injuries of the posterior wall of the duodenum), the external layer being closed first and the mucous layer next (*Wölfler's suture*); a through-and-through suture from the *inside* is known as *Connell's suture.* Continuous sutures make the most water-tight closures; but they should not be drawn too tight in circular closure of the bowel, for fear of causing undue constriction. Fine silk or chromic gut is used for bowel stitching, plain catgut being too easily digested. In order to protect the suture from irritation, and to facilitate the insertion of stitches, a number of absorbable **bobbins** have been invented for placing in the lumen of the canal,—decalcified bone (*Mayo Robson*, *Allingham*, *Stanmore Bishop*), chromicised gelatine (*MacLennan*), carrot (*Ullmann*), etc. All non-absorbable bobbins have been superseded by **Murphy's button,** a metal bobbin made in two halves, with a spring on one of the flanges, which crushes the intestinal walls together when the halves are joined, and holds them in contact till union takes place, after which the crushed part sloughs away, and so releases the button. If the bowel suture is not very secure it should be lapped round with a piece of omentum (*omental graft*).

Stomach and Pylorus.

Foreign bodies, if small and smooth, pass through the pylorus, and are ultimately ejected by the rectum. If sharp (like tooth-plates, nails, or hairpins) they may be retained, and be a source of danger from perforation. Sometimes hair accumulates, from the habit of chewing hair, and forms large *hair-balls* in the stomach.

Gastrotomy is opening the stomach for the removal of such bodies. For small articles a cone of stomach is pulled well out of a small abdominal opening, and an incision made in the apex. After the body is extracted the opening may be closed by a purse-string suture, the stomach returned, and the abdominal wound closed (*Senn*). For larger bodies the stomach is packed round with compresses, and a sufficiently large opening made to extract the body, and the incision closed by Lembert's sutures.

Gastrostomy is the formation of a permanent "mouth" in the stomach, when the cardiac end of the œsophagus is obstructed. The most efficient method of valve-formation, to prevent the escape of gastric juice, is that of *Kader and Senn.* A cone of stomach is drawn out of a wound made below the costal margin, and its base sutured to the edges of the opening in the deep fascia. A small puncture is made at the apex, and a rubber tube (No. 12, English catheter gauge) slipped in, care being taken that it penetrates the mucous membrane, and does not strip it up. A purse-string suture is applied round the apex and drawn tight; and the tube thus held firmly is pushed inwards to invaginate the cone. This is made permanent by a second and a third purse-string suture; and the edges of the skin wound are sewed to the cone, in order to prevent septic infiltration of the abdominal wall.

Feeding may be commenced at once if the patient is starving. The tube is withdrawn when it becomes loosened (after a week or so), and is only inserted at meal times. After a little practice the patient can feed himself, by chewing his food to a pulp, and then squirting it down a tube reaching from his mouth to the stomach. It is generally found that the obstruction in the œsophagus becomes diminished, and the patient often regains some power of swallowing after a short time.

Other methods may be employed:—*Witzel's,* in which a rubber tube is laid on the stomach, and the wall folded round it and fixed in position by Lembert's sutures, the lower end of the tube being inserted into a small puncture, and the stomach sutured to the abdominal wall. This method is useful especially when the stomach cannot be drawn far out on account of adhesions; it is used also for making an opening in the *jejunum* in cases of extensive carcinoma of the stomach.

In *Frank's* method a cone of stomach is drawn out, and sutured at its base to the deep fascia; the apex is drawn through a canal tunnelled in the subcutaneous tissue, and emerges at a second opening an inch or two above the first, so that the cone is acutely bent. The first skin wound is closed, and after a few days, when adhesions have formed round the second wound, an opening is made in the stomach. Other methods, such as *Marwedel's,* in which the canal is formed of the layers of abdominal wall, are now superseded by the above.

Gastric ulcers are treated by the physician. Hæmorrhage from *recent ulcers* does not require surgical interference; if slight, it stops spontaneously; if severe, it may prove rapidly fatal before help can be given.

Chronic ulcers may give rise to certain conditions requiring surgical treatment.

(1) *Dyspepsia and emaciation* in severe cases may require relief by gastro-enterostomy. This drains the stomach from its lowest part, and prevents irritation by undigested food and distension.

(2) *Hæmorrhage* from erosion of a large vessel embedded in a dense cicatricial base, which prevents retraction and spontaneous closure. Gastro-enterostomy acts favourably in these cases also by relieving distension; but in suitable cases it is better to excise the ulcer in addition.

(3) *Rupture* of a chronic ulcer may take place at any time, those on the anterior surface being more liable to do so, as the posterior wall of the stomach is less mobile, and is more readily covered with protective adhesions. It is often preceded by vague symptoms of indigestion, but comes on suddenly, as a rule after a meal. It may lead to general peritonitis if there is great effusion, or to localised abscesses if it leaks slowly through a small opening (*vide* p. 376).

(4) *Cancer* may develop in the edges of an old ulcer.

(5) *Peritonitis* in simple ulcers—apart from rupture or leakage—is mild in character, and limited to the immediate neighbourhood of the ulcer. It may cause adhesions to the abdominal wall or to the surrounding structures, which may require separation, if dragging pains persist, or if symptoms of obstruction develop.

(6) *Perigastritis* causes thickening and subsequent contraction of the outer walls of the stomach. This leads to distortions: (*a*) *stenosis of the pylorus*, caused by ulcers near the orifice, which gives rise to obstruction and dilatation of the stomach, increased by reflex spasm or by the sagging of the overloaded stomach; or (*b*) *hour-glass constriction*, caused by cicatrices of ulcers near the middle part, which divides the stomach into two or even three distinct sacs.

In **pyloric obstruction** there is persistent catarrh (induced by retention of irritant fluids), causing dyspepsia, with nausea, coated tongue, and eructations; and distension with gas from fermentation, giving rise to discomfort or pain. Vomiting usually occurs at intervals, and the matter ejected may be foul and sour from long retention. The dilated stomach tends to sink downwards; and in thin abdomens exaggerated peristalsis may be felt or seen moving from left to right. The limits of dilatation may be noted by auscultation-percussion after distension with air.

Diagnosis of simple dilatation from that due to cancer is sometimes difficult, as the symptoms in the early stages may be identical.

Surgical Treatment.

(i.) **Dilatation of the pylorus**, by (*a*) invaginating the anterior wall of the stomach with the finger, and forcing it through the pyloric opening; or (*b*) inserting the finger through a small opening in the stomach, and dilating the pylorus (*Loreta's operation*). Neither of these is reliable: severe hæmorrhage is not uncommon, and contraction is apt to recur.

(ii.) **Pyloroplasty.**—(*a*) An incision is made longitudinally in the narrow part, and the opening sutured transversely. The extent of dilatation by this means is restricted to 1-2 inches; and as there is always some contraction afterwards recurrence may take place; (*b*) the incision is carried for two or three inches into the stomach on one side, and the duodenum on the other (*gastro-pyloro-duodenostomy*), in a horse-shoe form, with the two limbs lying parallel; the duodenum is freely mobilised at its outer edge, and folded over, so that the limbs of the incision coincide. The edges are sutured together by drawing tight a number of Halstead's stitches which have been previously introduced (*Finney's operation*). Good results are reported of this method.

(iii.) **Gastro-enterostomy** (*Wölfler*) is anastomosis between the stomach and some part of the intestine. It may be made by suture, by absorbable bobbins of different kinds, or by Murphy's buttons.

(*a*) *Gastro-duodenostomy.*—The duodenum is loosened as in Finney's operation, and anastomosed to the stomach close to the pylorus. This is done sometimes when the pylorus is attached high up, and the duodenum and stomach hang nearly parallel.

(*b*) *Gastro-jejunostomy*, lateral anastomosis between the jejunum and stomach. The loop of bowel may be attached to the front of the stomach, (1) by looping it round the omentum and transverse colon (*anterior antecolic—Wölfler*); or (2) after perforating the mesocolon and gastro-colic omentum, (*anterior retrocolic—Brenner*); or (3) to the posterior wall of the stomach, by turning up the omentum and colon, and making an opening in the mesocolon (*posterior retrocolic*—*v. Hacker*).

"**Vicious Circle.**"—If the opening between the stomach and the efferent (distal) loop becomes obstructed in any way, the stomach contents do not drain away, but lodge in the afferent (proximal) loop until it becomes filled and distended; this collection, mixed with bile and pancreatic juice, is regurgitated into the stomach, and there sets up persistent and intractable vomiting. This is apt to appear about the third day after operation, and results in interference with absorption of food and liquids; and rapid wasting and exhaustion come on, which may cause death within a week or ten days. It is seen more frequently after cancerous cases; while in simple cases, and in retrocolic operations, it is comparatively rare. The chief cause is valve-formation at the junction of stomach and intestine, induced by dragging on the intestine, either from being attached too high on the stomach, or by kinking or pressure, especially mutual pressure of colon and jejunum in *antecolic* anastomosis; while twisting, or incarceration in an opening in the omentum, may cause regurgitation, or strangulation in addition. Owing to this danger antecolic anastomosis should only be employed when the other is not available, as for instance, when the stomach is retracted or fixed by adhesions.

The simplest method of *preventing* its occurrence is by making an anastomosis between the afferent and efferent loops (*Braun* and *Jaboulay*). This may be readily accomplished with Murphy's button, especially with the modification of *Weir*, by which the two halves may be dropped into the loops, and pressed together through the intestinal walls, the sharp edge of the male half cutting its way through both walls. To prevent incarceration of a piece of bowel in the pouch thus formed, the loops should be united along their contiguous surfaces. To avoid regurgitation more surely, the afferent loop may be constricted with a ligature, or by cutting it across and closing the blind ends. Instead of this the jejunum may be divided, and the efferent end implanted into the stomach, while the afferent end is implanted into the efferent one (*Y-gastro-enterostomy*). It may be performed in front of the stomach (*Doyen*), or behind (*Roux*). Regurgitation may be prevented also to some extent by opening the intestine by a curved transverse incision, and suturing this to the lower edge of the stomach (*inferior antecolic*) in such a way that a valve is formed to cover the afferent loop (*Kocher*).

(iv.) **Gastroplication.**—If the stomach is very much dilated, and the obstruction slight, several tucks may be taken in the wall by means of a series of Lembert's sutures; and this sometimes gives relief by preventing stagnation of its contents.

Congenital stenosis is thickening of the pyloric fibres, which sometimes forms a valve-like ring, and causes obstruction; it appears almost immediately after birth. The *symptoms* are persistent vomiting without apparent cause: dilatation of the stomach and retention of its contents, with consequent wasting, if the child lives long enough. Sometimes the symptoms do not appear for several years, and are less acute in character. It is *treated* as other forms of stenosis, by some *rapid* form of pyloroplasty or anastomosis.

Acute dilatation is a form of paralytic distension, which may occur, especially in children, after operations, or in the course of peritonitis, or even the acute infective diseases. It is very fatal.

Hour-glass constriction is characterised by the symptoms of obstruction and dilatation, with certain differences from that due to pyloric stenosis, viz.:—(i.) the stomach may be filled with a measured quantity of water, but only a portion of it is returned by the siphon; (ii.) it may be apparently emptied, but if the tube is left in for a little, a sudden rush of foul fluid appears (*Wölfler's first and second signs*); (iii.) succussion is still obtained after "emptying the stomach"; and (iv.) by auscultation-percussion after inflation it is often possible to mark out a sulcus at the lower border.

Treatment.—The two pouches may be joined together by **gastro-anastomosis** (or *gastro-gastrostomy*); or a long horse-shoe incision like Finney's is made in the stomach so as to make the pouches continuous (*Kammerer*): or a gastro-enterostomy may be performed with the loop of intestine anastomosing with each pouch by a separate opening (*Weir*).

Tumours.—**Myomata, fibromata,** and **lipomata** have been met with in the stomach, but they are rare. **Sarcomata,** though not rare, are not common. The most common tumour is *cancer*, forming about 95 per cent of all.

Cancer of the stomach occurs most commonly in men between the ages of forty and seventy; the scirrhus type being the most frequent, next the medullary, while the colloid form is only occasionally met with. It may be diffuse, or localised at the cardiac end, or the body, but more frequently near the pylorus.

Effects.—The lymphatic glands are affected early, nearly always before a definite tumour can be detected by palpation. The chief groups are the superior ones in the gastro-hepatic omentum, lying along the lesser curvature, and the inferior ones in the large omentum along the greater curvature. The liver also may be involved through the lymphatic or the vascular system; while the lungs are often invaded through the blood stream. Perigastritis with cicatricial thickening is an early effect; it leads to adhesions or distortions of the stomach. Ulceration may cause perforation, and lead to general peritonitis, or, more commonly, abscess, or by previous adhesions to neighbouring bowels, *gastro-intestinal fistula.*

The **symptoms** are chiefly those of chronic gastritis induced by the presence of the tumour; or of ulcer; or pyloric constriction caused by encroachment of the growth, or by perigastric thickening; later, those of cancerous cachexia appear, the most prominent of which are extreme wasting and anæmia with yellowness of the skin. Sometimes there are no symptoms to indicate a growth in the stomach, the first signs being those of secondary infections of other organs. In thin persons a tumour may sometimes be felt in the later stages of the disease. Pain may be absent if there are no deep ulcerations or dragging adhesions; but once established it is persistent, and unrelieved by vomiting. Hæmatemesis is frequent; it is usually slight in amount, but it may be profuse and fatal.

Diagnosis between cancer and simple forms of gastritis, ulcer, or pyloric stenosis, is not always easy. In cancer free *hydrochloric acid* is diminished, and finally disappears as the oxyntic cells become atrophied or destroyed; this is sometimes late in occurring, especially if the tumour is situated near the cardiac end. It may also disappear in extreme cases of chronic gastritis, but is seldom so permanently absent. In simple ulcers the acid is often in excess. Along with the absence of hydrochloric acid, lactic acid is apt to make its appearance from fermentive changes. Simple *tumours* may be formed of cicatricial material, or of omentum rolled on itself and matted by adhesions. The *pain* in cancer is constant, while in ulcer it is paroxysmal, and in gastritis it is often merely discomfort. *Vomiting* in cancer is frequent and gives little relief to the pain, while in simple ulcer it occurs with the presence of food, as a rule, and gives relief to the pain.

Treatment in most cases can only be palliative, as the real disease is so apt to be overlooked until too late for extirpation. The surgical treatment, therefore, is usually confined to (*a*) *gastro-enterostomy* by one of the methods mentioned above ; (*b*) where the cardiac end is also involved, *gastrostomy* in addition ; or (*c*) where the body of the stomach is widely infiltrated, by **jejunostomy,** in which a loop of jejunum is brought up to the abdominal wound, and an opening made to introduce a tube by *Witzel's method.*

In favourable cases, where the tumour is small and isolated near the pylorus, **pylorectomy** and **partial gastrectomy** are performed. This is done by clamping the stomach and duodenum with strong clamps, to prevent bleeding and the escape of their contents, resecting the part between the clamps, cutting at least two inches wide of the visible margin of the tumour, and closing the cut ends by Czerny-Lembert sutures. Communication is made into the intestine by gastro-enterostomy. The glands near the tumour, both above and below, are removed, whether enlarged or not. In a few cases it is possible to remove the whole stomach (**total gastrectomy**), and join the lower end of the œsophagus to the jejunum, or if that is impossible, perform jejunostomy.

Indications for *gastro-enterostomy* are persistent vomiting and dilatation, which cannot be controlled by medical means. Much of the discomfort is relieved, nutrition improves, and the growth of the tumour is retarded. Patients seldom live for more than two years after this operation ; but in favourable circumstances after pylorectomy they may live for several years without signs of recurrence. No form of *gastrectomy,* however, should be performed if there is a palpable tumour, or if the patient suffers from atrophy of the heart, with a pulse of very low tension, due to prolonged vomiting. A marked diminution of *sulphocyanide of potassium* in the saliva is a sign of great enfeeblement, and its absence indicates the approach of death. Any operation done in these circumstances will prove unsuccessful (*S. Fenwick*).

Duodenum.—Ulcer of the duodenum is much less common than that of the stomach, and it occurs more frequently in men between the ages of thirty and forty. The *symptoms* are similar to those of gastric ulcer; but there is less tendency to vomit, melæna is more common, and the pain does not come on for some time after food has been swallowed (*i.e.* till it has passed the pylorus). It is often unnoticed until stenosis or perforation takes place. The effects and *treatment* are similar to those of gastric ulcer.

Acute ulcers are sometimes met with in children after severe burns affecting a large surface of skin. They are not common, and their pathology is uncertain. Their course is usually rapid, perforation taking place early, and leading to peritonitis and death.

Intestines.

In laparotomies the small intestine is **identified** by the absence of longitudinal bands and appendices epiploicæ. The mesenteric attachment runs obliquely from left side of the vertebral column above to the right side below; thus the **direction** of the bowel may be determined by grasping a piece with the fingers on one side of its attachment and the thumb on the other close to the posterior wall, and tracing the mesentery up or down. The mesentery itself, also, tends to become more infiltrated with fat at its lower end. Further, the **distance from the duodenum** may be roughly gauged by noting the comparative length of the primary loops formed by the branches of the superior mesenteric artery, which are long in the upper part (3-6 feet from the duodenum), but in the lower part are short, and tend to divide into small and numerous (tertiary and quaternary) loops. The large intestine is usually easily identified, and its direction can be found by picking up a piece close to its abdominal attachment, and tracing it.

Congenital Malformations.—(I.) The chief is **Meckel's diverticulum,** which is present in about one person per hundred, and arises generally in the ileum, about 3 feet from the cæcum. It is usually wide and short, but may be a long, thin, solid cord, or may even open on to the umbilicus. It rarely gives rise to trouble, but inflammation (*diverticulitis*) has been noted, and is described as being in all ways analogous to appendicitis. The more common danger is from strangulation of a bowel either by (*a*) the long cord embracing a loop of intestine, or (*b*) the point of a short diverticulum becoming adherent to the abdominal wall or a neighbouring piece of bowel, and forming a bridle under which a loop is caught.

(11.) **Imperforate anus and rectum** (*vide* Diseases of Rectum).

Ulceration.—Ulcers occurring in the course **of enteric fever** may rupture on slight provocation. This is indicated by a sudden alteration in the aspect of the patient, rigidity of the abdominal muscles, and steady increase in pulse-rate. *Treatment* is immediate laparotomy and suture of the ulcer.

Tubercular ulcers of the intestine sometimes rupture. Also, if the disease subsides, the scar may give rise to a ring-shaped narrowing of the lumen, and cause obstruction. This is aided by the accumulation of solid material above the constriction; and even in the absence of true "ileus," it may give rise to similar signs.

Ulcers sometimes occur in the distended bowel above a point of **acute obstruction**; they are usually multiple and acute in character. Their presence is generally indicative of a very serious condition.

Constrictions are due to the results of the foregoing ulcers, syphilis, strangulated hernia, or intussusception, etc. and to the presence of tumours. In the small bowel, where the contents are mostly liquid, obstruction or impaction is unusual; but in the large bowel, especially in the lower part, where the contents become dry and hard, attacks of obstruction are common.

The **symptoms** are constipation, distension of the bowels, griping pains and vomiting. Peristaltic movements may be sometimes felt or seen through the abdominal walls. The attack passes off either spontaneously or by the help of drugs,—in the small bowel laxatives, and in the large bowel hyoscine or morphine. As the constriction increases the attacks become more frequent and severe, due partly to hypertrophy of the muscular tissue about the constriction, and stronger spasms. Finally, death may occur unless surgical measures are undertaken. In benign cases these consist of enterectomy where this is possible; otherwise, of "short-circuiting" the bowel by entero-anastomosis.

Tumours.—Benign tumours are rare; but *polypoid adenomata* are sometimes formed in the bowel wall, and predispose to intussusception by peristaltic dragging on the pedicle of the tumour. *Inflammatory masses* also may give rise to symptoms of tumours proper.

Sarcomata are occasionally met with, and are generally distinguishable from carcinomata by the absence of stenosis.

Carcinomata are commoner in the colon than in the small intestine, but still more frequent in the rectum. In structure and growth they resemble those of the stomach. They may exist for several years without producing alarming symptoms. Metastatic growths are late in appearing; and cancers of the bowel, therefore (and of the sigmoid in particular), are favourable for radical extirpation.

The **symptoms** are at first in general those of dyspepsia, with alternating constipation and diarrhœa, which gradually become more severe; abdominal distension and "colicky" spasms appear; and when obstruction becomes more marked, signs of "ileus" come on. A tumour may sometimes be felt if not too deeply situated. Deep ulceration is apt to lead to rupture and localised abscess, or, less commonly, to general peritonitis; but if the tumour bursts through the peritoneal covering, the whole abdomen may become invaded with cancerous nodules.

Treatment.—If the tumour is isolated the affected portion of gut should be excised along with a wide margin of healthy-looking tissue, since infiltration along the lymphatic spaces is always more widely spread than appears to sight or touch. Acute obstruction should be relieved by colostomy; and after a few weeks, when the patient has recovered, the radical operation may be carried out. If the tumour is adherent to the neighbouring structures, or if general dissemination has taken place, palliative treatment only is possible, *i.e.* short-circuiting the bowel, or, in extreme cases, formation of an artificial anus.

Operations on the Intestines.

Enterotomy is temporary opening of the bowel for the relief of impaction or of distension with gas, etc. (*vide* p. 390).

Enterostomy is making a permanent opening in the bowel, with an orifice in the abdominal wall, or in another part of the alimentary tract (e.g. *colostomy or fæcal fistula, gastro-enterostomy*, etc.). Of these, **entero-anastomosis** (*entero-enterostomy*, or *short-circuiting* of the bowel) is used when the tissues are healthy above and below a stricture, ulcer, or tumour, which cannot be removed. It is performed by approximating the peritoneal surfaces of two loops, and fixing them by Lembert's suture side by side; a parallel opening is made in each loop, of sufficient length to allow for subsequent narrowing, and the mucous edges sewed together with a circular suture, the first suture being continued round the wound in order to bury it.

Artificial anus is an external enterostomy in the colon, through which *all* the intestinal contents are discharged; this is secured by making a "spur," or fold of bowel wall, close to the opening, to act as a valve, or by cutting the intestine across, so that the ends are completely separated. The commonest sites for this are in the sigmoid flexure, for relief of obstruction from cancer of the rectum, and, less commonly, in the cæcal region for obstruction in some part of the colon. (This operation is still often spoken of as *colostomy*, or even *colotomy*.) It is now nearly always done in the *iliac* or *inguinal* regions, the *lumbar* operation being almost obsolete except for special purposes. An incision is made parallel to Poupart's ligament about an inch from the anterior superior spine; the muscles are separated and retracted, and the transversalis fascia and peritoneum opened. The skin incision may be as long as is convenient; but *for this operation* the deep incision should be only sufficient to admit two fingers, otherwise prolapse of the bowel is apt to ensue. The colon is felt for, identified by its longitudinal bands, and its direction is determined in order to avoid twisting the bowel on itself. It is brought well out of the wound, and its mesentery is pierced; and a solid rod, a strip of gauze, or a stitch between the skin edges, is inserted through the rent to prevent the colon from falling back, while a few sutures are applied to prevent it from slipping out. Adhesions form rapidly round the bowel, and it may be safely opened or cut across after two or three days; no anæsthesia being required. If the opening has to be made at once, the sutures must be applied closely all round, and the edges well packed with iodoform gauze.

Enterectomy is resection of a piece of the bowel for gangrene after thrombosis, or for constriction, strangulation, or malignant growths. The coil of bowel is well isolated and packed round with compresses. Two bowel clamps of any good pattern, or the fingers of assistants if available, are applied at both sides beyond the limits of the disease; in this way soiling of the wound with feculent material is avoided, and bleeding controlled. The bowel is now cut between the two clamps on each side, and the mesentery divided along its attachment, or, if diseased, removed by a wedge-shaped incision. The bowel is joined together by (1) *end-to-end anastomosis* by means of (*a*) *Murphy's button*; (*b*) *Czerny-Lembert suture*, with or without the aid of an absorbable bobbin; (*c*) *Maunsell's method*. (The free ends are joined by two temporary stitches, one at the mesenteric attachment and one at the opposite side. A slit is made in the distal portion of bowel about an inch from the end, and the long ends of the stitches drawn through, thus pulling out the joined ends, with one invaginated into the other, their peritoneal surfaces being in contact; the cut ends are sewed together through and through, and dropped back into the bowel, after which the slit is closed); (*d*) by *Ullman's method*, in which the suture of Maunsell's method is replaced by a strong ligature applied round the double layer of bowel over an absorbable bobbin. (2) Or by *lateral anastomosis*, after closing the ends by (*a*) *Czerny-Lembert suture*; or (*b*) *crushing* them with a powerful clamp (*histotribe*), so that nothing is left but two thin layers composed of the peritoneal and submucous coats; these are ligated, the projecting part cut off, and the ends buried by *purse-string sutures*. In any case the cut edges of mesentery are joined together, and if none of it is removed, the redundant portion is folded on itself and *sutured in place*, as any opening or pocket in the peritoneal surfaces is apt to induce internal hernia.

APPENDIX.

The **Appendix** is subject to disorders (inflammation, specific diseases, and tumours) like other parts of the intestines; but from its anatomical form and its relations, these conditions are considerably modified.

Appendicitis. Ætiology.—*Predisposing Causes.*—The length of the blind sac, and its comparatively narrow calibre, favour the stagnation of ingesta, and increase the virulence of its contained organisms; while the lymphatic tissue, so abundant in this part, is specially prone to infective processes, and the presence of the numerous follicles affords an easy entrance to bacteria. These conditions are increased by previous *pathological* or *physiological changes*, *e.g.* injuries, inflammations, menstruation, or natural involution, in which the mucous cells, otherwise protective against invasion, tend to atrophy. The age most prone to appendicitis is between ten and forty.

The *exciting causes* are traumatism (including strains, violent exercise) and exposure to cold; but most of all disorders of digestion, due in many cases to an unusually hearty meal containing indigestible material or ptomaine poisons. The presence of hard (but not sharp) bodies is probably of little effect in this respect. Rheumatism, influenza, and enteric fever are also credited with inciting an attack.

The *final cause* is infection by microbes. The normal appendix is never sterile; it contains usually many species of bacteria, including streptococci, staphylococci, and several anaërobic organisms, and invariably the bacillus coli. In pathological conditions the flora is the same, but greatly increased in numbers, while the number of species is generally less. When an acute attack has subsided, however, and the phagocytic action of the tissues has been freely exercised, the appendix has sometimes been found to be sterile; and this is common enough in chronic cysts of the appendix. Extra-appendicular abscesses in the acute stage always contain numerous bacteria; but, again, if the acute conditions completely subside, these are found to be sterile in a considerable proportion of cases (*Lanz and Tavel*).

Pathology.—Catarrh, in the first place, generally causes considerable swelling of the mucous membrane, and, once the limits of distension are reached, the lumen becomes occluded. This again causes (*a*) alteration in the condition of growth, and modifications of virulence, of the bacterial contents; (*b*) confinement of bacterial or other products in the blocked appendix; (*c*) increased absorption of those through the lymphatics; and (*d*) ulceration of the mucous membrane. Inflammation is seldom confined for long to the mucous membrane, and it soon becomes diffused throughout the walls of the appendix and the adjoining cæcum, (*typhlitis*); it may affect the blood-vessels with septic thrombosis, or the lymphatics, spreading to the ilio-colic glands on the posterior abdominal wall. Further, (1) the blood-supply, being restricted (in males at all events) to one or two small vessels lying along the appendix, may be cut off completely by thrombosis, causing *gangrene* of the whole organ; partial gangrene may also occur from (2) kinking, (3) compression by adhesions, or (4) pressure of a solid body (*e.g.* fæcal concretion) in the lumen.

Repeated acute or prolonged chronic attacks lead to atrophy of the mucous membrane and to cicatricial constrictions. If these are limited to the proximal part, secretion may continue in the distal end and give rise to a *cyst*; and if inflammation recurs, this may become purulent (*empyema*).

Secondary Effects.—It is in the neighbouring structures that the effects of appendicitis are chiefly felt. The peritoneum covering the appendix and the adjacent parts becomes inflamed, (*a*) by simple exudation of toxic products, resulting in adhesions wherever the appendix may touch; (*b*) by extravasation of bacteria through the *weakened* wall, resulting in adhesions if the infective agent is mild, but abscess-formation if virulent; (*c*) by perforation, resulting in general peritonitis, or, if the parts are walled off by previous adhesions, in localised abscesses.

Adhesions may cause (*a*) further constrictions, or kinking of the appendix itself; (*b*) strangulation of neighbouring coils of bowel by the formation of fibrous bands; (*c*) chronic constipation and colic by distortions of the bowels; and (*d*) dragging pains on movements of the psoas and other muscles. Adhesions at the tip of the appendix are not infrequently accompanied by small hidden abscesses.

Abscesses form usually in the immediate vicinity of the appendix or cæcum (*perityphlitic*). From this point they may spread behind the cæcum (*retrocæcal*), and upwards along the flank to the diaphragm (*subphrenic*), or even to the pleura; or downwards into the pelvis; or between the coils of bowel to the middle line, or to the opposite side, whence they may spread up in the left flank. Suppuration may also spread under the peritoneum (*retroperitoneal*), and cause abscess between the layers of mesentery, or in the perinephritic tissue; or penetrate into the abdominal wall, and give rise to diffuse suppuration. Abscesses may *open spontaneously* (*a*) on to the skin near the iliac region, at the umbilicus, or elsewhere; (*b*) into the cæcum (the most common route), rectum, or ileum, and occasionally into the vagina or bladder; and (*c*) into the general peritoneal cavity.

Thrombosis spreading to the mesenteric vessels may lead to hæmorrhagic infarction of the intestines, or to abscess of the liver. Inflammation may spread also by anastomosing vessels from the colon to the systemic veins, and set up thrombophlebitis of the veins of the legs.

Symptoms of Acute Appendicitis.—*Pain* always occurs at some time, and is referred at first either to the right iliac or the umbilical regions, or all over the belly; it begins suddenly, and recurs in spasms. Later, it becomes more localised in the right iliac region (especially when the appendix is adherent to the abdominal wall, or the parietal subperitoneal lymphatics are inflamed); but it may radiate to the kidney or scapula, or to the bladder, testicle, or thigh. It is excited by movements of the psoas and other muscles, and by coughing, etc. A sudden sharp pain after a subsidence often means a perforation or a commencing general infection. *Tenderness* is nearly always present, especially under *M'Burney's point* ("$1\frac{1}{2}$ to 2 inches from the anterior spine, on a line joining that point to the umbilicus"), corresponding to the origin of the appendix from the cæcum. Tenderness on pressure on the opposite side is generally reflex, and indicates peritoneal irritation; and hyperæsthesia of the skin is usually a sign of peritonitis. If the appendix occupies the pelvis the tenderness may only be elicited by rectal or vaginal palpation. *Rigidity of the abdominal muscles* is at first general, but afterwards is often confined to one side, or to a small area overlying the inflamed appendix. *Muscular spasm* is sometimes elicited on slight stroking, especially when the appendix is adherent to the abdominal wall.

Local swelling can rarely be detected in acute simple appendicitis. *Diffuse swelling*, where it is detected, generally is due to (*a*) fibrinous or serous exudation, or (*b*) abscess; while a definitely outlined tumour is generally (*c*) rigid muscle fibres, (*d*) a mass of œdematous omentum, or (*e*) a distended and stiff appendix, which becomes palpable only on subsidence of the general swelling and rigidity.

Constipation is the rule, and it generally persists until the acute symptoms are over. Sometimes cases begin with a sudden evacuation of the bowels, while in others diarrhœa is persistent. The *bowels* are usually somewhat *distended*; extreme distension, with persistent vomiting, is suspicious of general peritonitis or ileus. There is sometimes a temporary retention of *urine*, and often pain on micturition. *Vomiting* is more or less constant at the beginning of an attack, but it soon passes off; nausea generally accompanies it, and may persist for a longer time. Persistent vomiting and nausea, especially if accompanied by hiccup, is suspicious of general peritonitis, or pus in contact with the diaphragm.

Temperature varies greatly, and is very misleading. As a rule, it is slightly raised, varying from 100° to 103° for the first few days, but gradually falling to normal as the attack subsides. Low temperature with a good pulse usually indicates a mild attack; but if accompanied by a quick and thready pulse, and low leucocytosis, it is suspicious of a very severe attack, or rupture with peritoneal absorption. Rising temperature, accompanied by chills and increasing leucocytosis, points to formation of pus (abscess or purulent peritonitis). High temperature with morning remissions indicates abscess; renewed pyrexia after some improvement has taken place indicates a secondary extension; while continued high temperature with recurrent rigors indicates pyæmia.

The *pulse* is of great importance; very rapid pulse is always grave; and a rapid pulse out of all proportion to the degree of pyrexia often presages a fatal termination. At the beginning it is always accelerated, but gradually declines as the acute process subsides. With spreading peritonitis the pulse is rapid and full: with extreme tympanites it is sometimes of high tension; but with severe intoxication it is weak and irregular. In rare instances the pulse remains good even in fatal cases.

General conditions: in mild cases, after the first few hours, the patient is slightly flushed, suffers from a little headache and thirst, but is not otherwise very uncomfortable (indeed a patient may sometimes feel so well, that he is at work or play even after a large abscess has fully developed). The body is usually recumbent, and the right leg flexed, to relax the psoas and abdominal muscles. If general peritonitis or abscess occurs the aspect of the patient changes accordingly.

Complications.—The commoner ones are extra-appendicular abscess as noted above, and general peritonitis resulting from perforation of the appendix or rupture of a localised abscess. The less common are pleurisy, cystitis, and even purulent nephritis, and fatal hæmorrhage from erosion of a large artery.

Varieties of Appendicitis.—The so-called "**fulminating appendicitis**" is the form in which the process is confined to the appendix, and is of such intensity as to cause complete gangrene or a perforation, and so flood the abdomen with toxic material before any definite signs of illness are noted. Owing to the absence of sensory nerves in the appendix and intestines, this may easily happen if the inflamed appendix is kept from contact with the abdominal parietes, and if the inflammation of the lymphatics is confined to the immediate neighbourhood. The only available *premonitory signs* in such cases are (1) the history of previous attacks of intestinal disorders, (2) constipation, sometimes alternating with diarrhœa, and (3) slight pyrexia with chilliness and headache, coated tongue and loss of appetite. The danger of these cases is obviously extreme.

Chronic appendicitis may follow an acute attack, or be chronic from the beginning. Three fairly distinct clinical forms are recognised: (*a*) *recurrent*, in which the attacks are more or less acute, and are repeated at intervals, the intervening periods being free from any evidences of disease; (*b*) *chronic relapsing*, in which the patient is never well, and is subject to acute exacerbations; and (*c*) *residual*, in which the symptoms are due to adhesions, kinks, etc. Any of these forms may be combined with the condition of *latent appendicitis*, in which the infective process is in a quiescent state, and is liable to burst into activity, and often terminates in perforative peritonitis.

Symptoms.—The *recurrent* forms are similar to the acute. In *residual* conditions the chief symptoms are obstinate constipation, sometimes alternating with diarrhœa, and even associated with *membranous colitis*; flatulence, either general or located in the iliac region; pain and tenderness, excited or aggravated by certain kinds of food, or by traumatism from general over-exertion, or excessive movements of the psoas muscle; chronic dyspepsia; and general malnutrition, which may be due to the presence of the septic focus in the alimentary canal. In women dysmenorrhœa is not uncommon as a result.

Diagnosis.—*Acute appendicitis* must be distinguished from (1) intestinal obstruction from any cause; (2) gastro-enteritis and enteric fever; (3) peritonitis; (4) affections of the ureter or kidney, or the passage of a calculus; (5) inflammation of the gall-bladder or passage of a gall-stone; and from (6) pleurisy affecting chiefly the diaphragmatic surface. *When exudation has occurred* it has to be distinguished from (7) impaction of fæces or foreign bodies; (8) intussusception; (9) malignant tumours; and (10) enlarged tubercular glands. *Perforation* may simulate (11) rupture of a gastric or intestinal ulcer, or (12) a tubal pregnancy. *The chronic form* is to be distinguished from (13) simple chronic dyspepsia and constipation; (14) peritoneal tuberculosis; and (15) in women, dysmenorrhœa due to other causes.

Prognosis in all cases is uncertain. An ordinary acute attack, unaccompanied by suppuration, generally subsides within eight or ten days, and the inflammation has disappeared in three weeks. Any case, however, acute or chronic, may end in suppuration or perforation; and all cases are liable to relapses or recurrences. With localised abscess the prognosis is fairly good, if surgical treatment is promptly carried out, but convalescence is apt to be tedious. In cases of sudden perforation the danger is naturally great, varying with the interval between the rupture and operation, and the consequent extent of infection of the general peritoneum.

Treatment.—Owing to the uncertainty of the outcome of any attack, the surest means of relieving the patient of the danger and discomforts of the disease is to remove the appendix before dense adhesions, suppuration, or perforation occur, *i.e.* within twelve or twenty-four hours of the *onset*. But it is often impossible to carry out this plan within these limits of time, beyond which operation becomes much more formidable. The general practice, then, in this country, is to treat all first attacks by physiological and medical means, but to prepare for immediate surgical interference should it become necessary.

The patient is kept in bed; all food is withdrawn for the first twenty-four hours, by which time vomiting has generally ceased: cooling drinks may be given in reasonable quantities: and afterwards the diet is restricted to fluids and jellies until convalescence begins to be established. If the bowels are loaded a glycerine injection may be given the first day, preceded, if the faeces are hardened, by a small enema of olive oil; but large soap-and-water enemas should be avoided, as they are apt to cause excessive peristalsis and colic, and possibly encourage rupture of a diseased bowel. Hot fomentations or ice-bags on the iliac region may relieve pain. In adults a grain of opium (or $\frac{1}{6}$ gr. of morphine) may be given for the same purpose and to control peristaltic movements.

The **indications for operation** during an attack ("*à chaud*") are (1) an acute attack, seen within a few hours, if permission can be obtained: (2) all cases of rupture ("*fulminating*"); (3) every case, at any stage, when suppuration is diagnosed; (4) cases of ordinary acute appendicitis which are manifestly getting worse; and (5) cases which, though not getting worse, are not making any improvement after a week.

Prophylactic Operations.—Undoubtedly a large number of cases of acute appendicitis recover, and do not recur, but this immunity can never be relied on; and every appendix which has undergone a definite acute attack, or more than one mild chronic attack, should be removed. This operation should not be performed until all acute inflammation has subsided, *i.e.* in about three weeks, when it can be done with great safety ("*à froid*," or "*on the quiet*").

Operations. The incision most convenient for exposing the appendix is one about 3 or 4 inches in length, nearly parallel to Poupart's ligament, and about one inch from it (*Roux*, *M'Burney*). The muscle fibres are separated, and drawn apart with retractors, and a small opening made in the transversalis fascia and peritoneum. When the appendix is suspected to be nearer the middle line, the incision may be made just inside the semi-lunar line, through the skin and anterior sheath of the rectus, the muscle retracted inwards, and the posterior sheath opened an inch towards the middle line (*Battle*, *Kammerer*); the nerves must be drawn aside and protected from injury, hence any enlargement of this incision should be made transversely.

The appendix is located by tracing the longitudinal bands to their point of meeting, where it arises from the cæcum. If it is behind (*retrocæcal*), the cæcum must be turned forwards to expose it; if also *extraperitoneal*, the outer attachments of the cæcum must be first loosened by dissection. The cæcum is packed round with compresses; the appendix separated from its adhesions, with special care lest a small abscess be hidden amongst them. The meso-appendix is divided between forceps, and the base of the appendix itself crushed with a powerful broad clamp close to the cæcum, while the vessels are being tied. A purse-string suture is placed on the cæcum around the appendix; the stump, which is now crushed quite thin and translucent, is ligated with chromic gut, and the appendix cut off: the end is disinfected by cautery or pure carbolic acid, and depressed with a fine forceps (or, as some surgeons prefer, invaginated into the cæcum without ligation), while the purse-string suture is tightened; and the dimple sometimes covered in with a second Lembert's suture. Many other methods are in use, such as making a "cuff" of muscular layer and peritoneum to cover in the stump; or excising the base of the appendix flush with the cæcum, and closing the aperture with the usual bowel sutures.

The wound should be carefully closed in order to avoid hernia-formation. Where there is any small abscess or necrotic patch (which it is impossible to trust to being sterile), a narrow drain leading down to it must be inserted for three days at least: after which, if no suppuration occurs, the orifice may be closed with secondary sutures. If too much stump is left, or if it is buried without proper disinfection, further inflammation or an abscess may arise. In suppurative cases the abscess may be opened through the iliac incision; but it is less necessary to save the muscles if more room is required, as healing takes place by second intention. Abscesses forming elsewhere than over the appendix should be opened directly where they point; an abscess shut off from the general peritoneum, discovered after opening the abdomen, should be drained if possible through a separate extraperitoneal opening. When the appendix is surrounded by an abscess it may slough, and be found lying free in the pus; or it may undergo atrophy and give no further trouble. This cannot be counted on, and it is safer in all these cases to dry out the cavity and pack it lightly with iodoform gauze for drainage; in a few days, when the suppuration has subsided, the appendix can be exposed and removed with comparative safety. When sudden rupture has occurred immediate operation is necessary; the sloughing appendix must be removed and the cavity drained, and all localised effusions should be dried out; but, unless signs of general peritonitis have shown themselves, it is better not to flush out the abdomen, for fear of spreading the infective material, and of weakening the absorptive power of the peritoneum. General peritonitis is treated as previously described.

Tuberculosis located about the appendix and cæcum is not uncommon: it usually gives rise to symptoms resembling those of chronic appendicitis.

Tumours.—Benign tumours are rare; but **carcinomata** are sometimes found in the appendix after removal for apparently simple appendicitis.

INTESTINAL OBSTRUCTION.

Intestinal obstruction, or blocking of the canal (*A*) by mechanical means, arises from many sources. I. *Internally*, from (1) fæcal masses, (2) foreign bodies, or (3) tumours; II. *inherently*, from (4) stenosis: III. *externally*, from (5) pressure of external tumours and cysts, (6) constriction by bands, etc., (7) volvulus, (8) hernia, or (9) intussusception. It occurs also (*B*) from (10) *paralysis* of the bowel ("paralytic ileus"), due to peritonitis, thrombosis of the mesenteric vessels, or to diseases of the central nervous system.

I. (1) **Masses of hardened fæces** (*scybala*) are apt to collect in the saccules of the great bowel, where they become dried and nodular, and may completely occlude the lumen. The occlusion is at first generally incomplete, however, so that the fluid fæces are allowed to pass, while more solid particles are retained and add to the obstruction. When the limit of capacity is reached complete obstruction occurs, with its general symptoms to be noted below, and with a palpable tumour or multiple nodules in the belly, usually doughy in consistence, though sometimes quite hard. The chief conditions favouring this occurrence are eating quantities of indigestible food, neglect of the bowels, chronic constipation, dyspepsia, and atony of the intestines due to old age, chronic or exhausting diseases, and sometimes to a congenital tendency met with in children (*idiopathic dilatation*). Constriction or previous damage to the bowels are also predisposing agents. The continued presence of scybalæ may cause ulceration and perforation, and in the acuter obstruction may encourage formation of multiple ulcers above the obstruction.

(2) **Foreign bodies** include all sorts of articles, which cannot undergo digestion, swallowed by children and insane or hysterical people; gall-stones, especially those of large size; and intestinal concretions ("avenoliths" formed by aggregation of fibres of oats or other seeds, and "enteroliths" formed by accretion of phosphates, etc., round some nucleus). The usual point of impaction is the lower end of the ileum, or at any constriction occasioned by anatomical or pathological causes. A tumour-like swelling may sometimes be felt on deep palpation.

(3) **Tumours growing from the inner walls** of the bowel, and blocking the lumen, are chiefly polypoid adenomas or lympho-sarcomas. They are commonest in the rectum or colon, where they may be felt by rectal or abdominal palpation. The simple tumours are not uncommon in children, and give rise sometimes to intussusception. These tumours often bleed profusely, and may snap at their pedicle, and be discharged by the rectum, thus relieving the obstruction.

II. (4) **Stenosis** arises from congenital malformations (*e.g.* imperforate anus); from inflammatory thickening, often the result of appendicular perityphlitis, or inflammation of the female organs, generally situated about the lower end of the ileum or the caecum; from contraction of ulcers, especially those arising from dysentery or tuberculosis—the former being commonest in the colon and often accompanied by exuberant cicatricial tissue, and the latter commonest in the ileum and often annular in shape; from malignant tumours obstructing the lumen by their bulk inside, while cicatrisation outside constricts the circumference—commonest in the caecal or sigmoid regions.

III. (5) **Pressure from without** arises from tumours or cysts of the ovaries or kidneys, from enlarged spleen, hydatid cysts projecting from the liver, displaced uterus (especially if gravid and enlarged), simple inflammatory and other swellings of omentum, cancerous masses, and even large abscesses.

(6) **Constrictions by bands** arise from (*a*) inflammatory adhesions between two parts becoming stretched and thinned. Or from (*b*) natural structures whose free extremities have become adherent to another part, so as to form a bridle under which a loop of bowel is caught: those are Meckel's diverticulum (a common source of obstruction), the vermiform appendix, the Fallopian tubes, an enlarged ovary with a long pedicle, the omentum, and the appendices epiploicæ. This form usually occurs in young people, and is rare after forty.

(7) **Volvulus** is (*a*) twisting of the bowel on its axis, or kinking from dragging against an adhesion, so that the lumen is blocked; (*b*) twisting of a loop of bowel on its mesentery, so that its mesenteric vessels also are obstructed; and (*c*) twisting of one loop of bowel round another. The second form (*b*) is the most frequent, and occurs generally at the sigmoid flexure, where the conditions are favourable to its occurrence, *i.e.* a long movable part attached firmly at each end; it is commonest in middle age, after forty. The third form (*c*) is apt to occur in the small intestine after intestinal operations of various kinds, if precautions are not taken to avoid it.

(8) **Hernias** occur at any age, and consist of (*a*) protrusions through the abdominal walls,—*external hernias* (*vide* p. 423); and (*b*) protrusions through natural or artificial openings or pockets in the abdominal cavity,—*internal hernias.* The latter comprise hernia through (*a*) the foramen of

Winslow into the lesser omental sac, (*b*) through openings in the diaphragm (dilation of arcuate ligaments, congenital defects, or stab-wounds); (*c*) into a duodeno-jejunal pouch, (*Treitz's* or *subperitoneal hernia*); (*d*) into one of the pouches in the ilio-cæcal region (*paracæcal*); (*e*) also in the sigmoid mesocolon (*intersigmoid*); and other accidental pouches; (*f*) through an opening in the mesentery, or (*g*) omentum, occurring either as a result of operation or injury, or by weakening through atrophy, and occasionally from a congenital defect: also (*h*) through a slit in the broad ligament of the uterus, or (*i*) the suspensory ligament of the liver, or elsewhere.

(9) **Intussusception** (*vide* p. 420).

B. (10) "**Paralytic Ileus**" (*vide* p. 422).

Pathology.— In internal and inherent obstructions the fæcal stream only is blocked. The symptoms arise chiefly from spasmodic contractions and accumulation of gas, which cause great pain and exhaustion; from general starvation: and from toxic absorption, giving rise to marasmus. In the external varieties, besides occlusion of the bowel lumen, the blood-supply is interfered with (**strangulation**). A knuckle of intestine is twisted or compressed, and the mesentery becomes constricted, so that the venous return, at all events, is obstructed, causing the bowel to become at first bluish in colour, then dark purple. This leads also to œdema and swelling of the bowel walls, and encourages distension with gas (*tympanites*) formed by decomposition of the contents. Meanwhile the poisonous material in the bowel is exuding through the damaged walls, and giving rise to toxæmia and shock. This may occur even in the absence of complete occlusion of the intestinal lumen, provided that part of the wall is strangulated (*e.g.* Littré's hernia). The constantly increasing distension may cause more bowel to be dragged into the constriction (or hernia); and the distended bowel may cause pressure against another loop, and so give rise to a second focus of obstruction. Distension tends to further compression, and the blood-supply may be completely cut off, in consequence of which the bowel will rapidly necrose: the colour becoming black, grey, or mottled with green spots, the lustre of the surface quite lost, and the consistence soft or doughy, instead of elastic. When a gangrenous bowel ruptures, general peritonitis is the usual result: though there is often a temporary and fallacious relief of symptoms at this occurrence.

The accumulation of poisonous material above the obstruction, together with distension, venous stasis, and inflammation in the vicinity, often gives rise to small *multiple ulcers*, scattered for several feet above the point of constriction; and these may cause perforation and death, even after the primary point of obstruction has been removed.

The **symptoms** are either acute or chronic. The former are met with in obstruction by constrictions, volvulus, hernias, and intussusception, in all of which strangulation is apt to occur early; death, in untreated cases, usually occurs in four or five days. The latter are often present in the other forms, and they may be intermittent and subacute, or continuous and chronic; but at any time they are liable to become acute.

Acute obstruction gives rise to a series of phenomena grouped together as **ileus** (*εἴλειν, to twist*). (1) *Pain* comes on suddenly if strangulation is rapid, but gradually if slow. It is referred either to the umbilicus, or at the point on the abdominal wall nearest to the attachment of the constricting structure. It is very severe and griping in character; and differs from that of peritonitis in that it is more localised, the general tenderness of the abdomen and rigidity of its walls are much less pronounced, and pressure on the belly may even relieve it. Later on pain is still further aggravated by distension of the bowels, and by commencing peritonitis. (2) *Collapse* is always present, but varies in acuteness according to (*a*) the suddenness of the lesion to the bowel and its nerves; (*b*) the locality of the obstruction (being more severe when the small intestine is affected); (*c*) the extent of the bowel implicated; and (*d*) the severity of the damage and the amount of poisonous material effused. Death, when it occurs, is due to collapse from septic intoxication. (3) *Vomiting* is constant and persistent, thwarting all attempts at feeding by the mouth. The vomit is at first stomach contents and bile; later, brownish acid fluid; and, finally, offensive and feculent material. This *stercoraceous vomiting* appears early when the obstruction is in the small intestine. It is accounted for in various ways, none of which are conclusive; the vomiting, at all events, involves the upper intestinal tract as well as the stomach, and the contents become rapidly feculent from decomposition in the presence of the *bacillus coli*. True faecal vomiting is uncommon. (4) *Stoppage of the bowels* is complete, not even flatus being passed, though sometimes tenesmus comes on intermittently. At first there may be an evacuation of the bowel below the obstruction, but afterwards constipation becomes established, if not by complete occlusion, then by reflex action (as in the cases of paralytic ileus and Littré's hernia). (5) *Meteorism*, or distension of the bowel with gas, accompanied by violent spasmodic peristalsis, always occurs sooner or later above the obstruction, and between the points of constriction; and it may attain to enormous dimensions, while the bowel below it is generally empty and contracted. It is dependent chiefly on fermentation of the faecal contents, modified by interference with the circulation in the bowel walls. When the abdomen is opened, the intestines, relieved of their controlling pressure, dilate still further, and, in extreme cases, may rupture on slight provocation. In stricture of the colon there may be "ballooning" of the rectum, probably of reflex origin. (6) *General conditions.*—The face is often characteristic, (*facies Hippocratica*), the features are sunken, the nose pinched, and the expression generally careworn and anxious; this is in great measure due to drying up of the body on account of the constant vomiting of fluid, and the inability to replace it by ingestion through the mouth. The urine also is scanty and high-coloured, and there is always distressing thirst. The skin is cold and clammy, and the temperature is generally a little subnormal. The pulse is rapid, and becomes weak and thready if peritonitis ensues. The tongue becomes dry and brown: and the mouth is often scored by dribbling of the acrid vomit. Occasionally there are cramps in the limbs, hiccup, or retention of urine.

In **chronic obstruction** the symptoms come on gradually. They are often intermittent, but at each recurrence they tend to be more severe. The most prominent features are griping and sometimes agonising pains, which are often induced by indigestible foods, especially by such as cause fermentation and flatus. In the intermediate periods the patient may be almost well, but may suffer from indigestion of some sort. Constipation is the rule, though fluid faeces are able to pass; and there may be *spurious diarrhœa*, or a flow of mucoid liquid, due to catarrh excited by retained faeces. By degrees the constipation becomes more complete, and vomiting begins to appear at each attack, usually accompanied by collapse, and locally by visible peristalsis and gurgling in the abdomen. Indigestion becomes worse, and gives rise to emaciation; and marasmus ensues from perpetual absorption of toxins, the breath sometimes becoming fæcal in odour; and, finally, death occurs from exhaustion, or from an attack of acute and violent ileus.

Diagnosis.—The condition most resembling obstruction is *peritonitis* in the early stages; but pain is less spasmodic, abdominal tenderness and rigidity more severe, and always elicited by palpation; vomiting is less persistent, and not so often feculent; the temperature after the first shock has passed off is inclined to rise rather than fall; and constipation and meteorism are not so constant.

In obstruction of the *small intestine* the pain and collapse are much more severe, and stercoraceous vomiting comes on earlier; while in that of the *large intestine* the symptoms as a whole are less acute, but meteorism appears early, and is more pronounced, and tenesmus is not uncommon.

In obstruction from *fæcal accumulation* and *internal tumours* there are generally premonitory signs before the acute attack, and a tumour-mass may be felt. In that of *foreign bodies*, the history of such being swallowed may be obtained, or information may be got by X-rays. In *stenosis* due to *inflammation* there may be a history of previous acute disease; while in that due to a *tumour* the mass may be felt, especially when the patient is anæsthetised. *Pressure of external swellings* generally begins in a chronic way, and the offending mass may be felt by abdominal, rectal, or vaginal examination. *Constriction by bands*, etc., *volvulus*, and *internal hernias* usually come on suddenly without warning; often no history of localised inflammation can be obtained, though it is of high significance when available. *Intussusception* occurs most frequently in young children; the invaginated bowel makes a sausage-shaped mass, which is revealed by palpation or percussion, and is sometimes felt presenting in the rectum; and there is generally a discharge from the anus of blood-stained mucus. *External hernias* are usually detected by appearing in the usual sites. *Paralytic ileus* is accompanied by other acute inflammatory conditions, or severe nervous disturbance. In all *cases of doubt* the rule is to make an abdominal incision, and prepare for any of those conditions.

Prognosis.—The acute forms if unrelieved are almost invariably fatal, from septic absorption through the peritoneum, or from rupture. Chronic, or intermittent subacute, cases may, under careful medical treatment, be kept under control for several months or years, according to the origin. Those arising from scybalous impaction, when once relieved, may be kept in subjection by regulation of diet and bowels.

Treatment.—*External hernias* are detected by examination of the orifices in the abdominal wall, and treated as will be described later. In obstruction due to *fæcal impaction* the pain may be relieved by warm fomentations, belladonna, and opium. Food should be restricted to jellies, soups, and barley water: all articles, including milk, which form indigestible remnants, being withheld, and no food given by the mouth if vomiting continues. Purgatives only increase the distressing symptoms; but, in the less urgent cases, injections of oil are of use for softening the fæces, lubricating the canal, and facilitating evacuation of the bowels by large soap and water and turpentine enemas. These should be repeated twice a day until the symptoms subside, the abdomen remains flat, and free from hardened masses, and the bowels move spontaneously. In urgent cases, and in obstruction from *foreign bodies*, etc. inside the canal, relief should be given by colotomy and removal of the offending body, the bowel being afterwards sutured, and the abdomen closed. In some cases, however, where the bowel is not readily emptied, Paul's tubes should be inserted and left for a day or two.

Strictures causing obstruction should be excised by enterectomy where that is possible; and, if malignant, a wide margin must be taken along with the palpable tumour, and any enlarged glands in the vicinity removed also. Where resection is impossible, on account of adhesions, or where the progress of the disease is beyond hope of eradication, an anastomosis should be made between the nearest parts of the intestine above and below the stricture (*short-circuiting*); but care should be taken not to isolate too great a length of small intestine, for fear of inducing asthenia from deficiency of digestive and absorptive surface. Stricture of the sigmoid flexure should be treated by inguinal colostomy above the obstruction.

For *internal hernias*, *volvulus*, *obstruction by bands*, or *ileus* of doubtful origin, the only treatment is immediate laparotomy. Once the diagnosis is made, a little morphine or hyoscine may be given to diminish pain and shock, and so favour the conditions for operation. After the abdominal incision is made, if the cause of obstruction is not at once evident, the hand should be swept first down to the right iliac region, where so many abdominal disorders have their origin, the inguinal rings being felt in passing; then up to the hepatic and splenic flexures, and down to the sigmoid and pelvis; if the obstruction is still not found, the small intestine must be passed through the fingers systematically, beginning at the jejuno-duodenal junction, where the commencement of the bowel can be easily identified. All constricting bands must be divided between ligatures; an adherent vermiform appendix or Meckel's diverticulum removed (the latter by ordinary bowel resection if large, or like an appendix if narrow); and a volvulus untwisted, or resected if the bowel is damaged beyond recovery. When tympanites is more than moderate, it should be relieved by colotomy, and, if well marked, by introduction of Paul's tubes.

The *condition of the strangulated bowel* after relief of constriction is most important. Even if it is almost black in colour, provided that the surface remains lustrous, it may still live. Time should be allowed for the circulation to become restored, and meanwhile the loop is covered with compresses wrung out of warm saline solutions. If the bowel is dead, and if the patient's condition warrants further operation, the segment may be resected; but all that part of the bowel and mesentery which includes any of the stagnant blood stream must be excised.

Should the patient be too much collapsed for any such operation, the bowel must be rapidly drawn out, and opened to form a false anus, preferably with the aid of Paul's tubes; the abdominal wound being packed, and a stitch or two being inserted into the bowel, to prevent it from falling back. If the patient recovers, a more radical operation may be considered. Meanwhile, in all these cases, an infusion of warm saline into the abdomen improves the condition of the patient, by diluting the poisonous exudation, and by relieving shock through absorption of the fluid into the blood.

After-treatment.—If the immediate treatment is successful, the patient is kept in bed until the wound is healed. If the bowel has been injured, the diet must be easily and fully digestible and unirritating; this must be continued for at least three weeks, after which the bowel may be considered to have recovered its tone. Sometimes a form of paralytic constipation comes on, requiring treatment by strychnine and mild laxatives; and there may be even a permanent atrophy of the intestine. The possibility of further (secondary) strictures must be kept in mind.

Intussusception is prolapse of one part of the bowel into the lumen of the part immediately below it. Three layers are thus produced, the outer one or *intussuscipiens*, and the two inner ones forming the *intussusceptum*, and comprising the innermost or *entering* layer, and the middle or *returning* layer. Four forms are recognised : (1) **enteric**, affecting the small intestine only ; (a rare form in the living, but sometimes found in the dead as a result of irregular peristalsis in the dying, and often multiple, and ascending or "retrograde"); (2) **colic**, confined to the large intestine, and met with generally in the descending colon and sigmoid flexure ; (3) **ileo-cæcal**, where the ileum, preceded by the ileo-cæcal valve, prolapses into the colon ; this being the most common form of all ; (4) **ileo-colic**, in which the small intestine prolapses through the ileo-cæcal valve ; in this case the invagination increases at the expense of the *entering* layer, at least until no more can enter—thus differing from all the others, which increase at the expense of the *intussuscipiens* only.

Intussusception is rare in adults, and is then generally chronic ; but in children, and especially in infants, it is common, and is mostly acute, and often fatal.

Ætiology.—The colon, in infants especially, is relatively much wider than the ileum, and if the latter should pout into it on account of any irregular peristalsis, it may be gripped and drawn inwards. Such spasms may originate with worms, undigested food, purgatives, or with localised typhlitis. Any pendulous body, like a polypoid tumour, or an appendix projecting its base into the cæcum (more especially if completely inverted), may induce intussusception by being caught in the downward peristalsis.

Pathology.—The bowel always enters the lower part from above (descending) ; and the mesentery is, of course, drawn in with it. This produces a firm rounded mass, which, on account of the dragging at its mesenteric border, assumes a curved shape. Sometimes it is only an inch or two in length, and occupies the iliac fossa ; but it may fill the transverse or descending colic positions, and descend to the anus, or even project through it. The appendix follows the cæcum, and is buried in the intussusceptum ; but it may become inverted, and appear in the rectum hanging free. In the more severe form, and especially in infants, the combined mass of bowel and mesentery soon distends the intussuscipiens to its utmost, and the mesenteric vessels become obstructed; this leads to œdema and swelling, which prevents reduction, and effusion of mucus tinged with extravasated blood; and later to gangrene and sloughing of the inner layers. Meanwhile, effusion and inflammation take place between the peritoneal (inner and middle) layers in contact, which not only give rise to septic intoxication, but also to gluing of the parts together; in exceptional cases, where gangrene of the inner parts takes place, this adhesion prevents extravasation and peritonitis, and thus effects a spontaneous cure.

The **symptoms of acute intussusception** begin with pain, generally sharp and spasmodic at first, but afterwards becoming more dull and constant, and located often in the right flank. It is accompanied by shock, which in infants may be very profound. Vomiting is not common; but there is tenesmus, and, after a little, discharge of blood and mucus, and sometimes diarrhœa. There is little meteorism as a rule, and the belly walls are lax; the tumour, therefore, can usually be easily felt in the right iliac region, or as invagination proceeds, moving towards the hepatic flexure and transverse colic region, and in more advanced cases appearing in the rectum, where the tip of the invaginated bowel may be felt like an os uteri. If unrelieved the patient dies of septic intoxication, or rupture and peritonitis.

In the **chronic form** all the symptoms are less marked and more inconstant. The pain is less severe, and vomiting is more common, especially after taking food. There may be constipation or diarrhœa, and tenesmus is generally present. A tumour is often palpable through the abdominal walls or even by the rectum. The intermittent and recurrent forms in older children often subside spontaneously, by keeping the patient in bed, withholding all food but soups for a day or two, and giving a small quantity of opium to reduce peristalsis. Death, when it occurs, is from marasmus, or perforation of multiple ulcers, or from a chronic case becoming acute.

Diagnosis (*vide* p. 417).

Prognosis.—The acute cases are very dangerous. In infants under one year, cases which cannot be *reduced* by operation or otherwise, but require resection, are almost invariably fatal; those which can be reduced by means of an abdominal incision are slightly more favourable; while those which are reducible without laparotomy are rather more satisfactory, provided shock is not too profound. Even then recurrences may take place, or a stricture may form later at the site of the constriction. In older children, and in adults especially, the prospects are brighter—prognosis as a rule improving the more "chronic" the conditions.

Treatment of acute intussusception is laparotomy without delay. Injections of oil or insufflation may in *slight* cases reduce the prolapse, but in most instances they are waste of time. In children especially shock must be counteracted in every possible way; and as soon as the abdomen is opened the intestines may be flooded with warm saline solution. Reduction should only be attempted by squeezing the lower part, in order to lessen the œdema and to permit withdrawal by pressing upwards; pulling at the other end is dangerous, and, if the bowel is firmly adherent, there is almost sure to be some necrosis requiring resection in any case. If the bowel cannot be reduced, a longitudinal incision must be made in the sheath, the inner layers cut across and joined by *Maunsell's method*, or more quickly by inserting a decalcified bone bobbin, and tying it round with strong silk, including both layers of the intussusceptum (*Ullmann*). The loose portion is removed, and the incision in the bowel sutured and covered with an omental graft. The parts must be packed round with compresses, and if possible brought out of the abdomen before the bowel incision is made; afterwards the bowels are again flushed with saline, and the abdomen closed.

In **chronic and subacute** cases the bowel is less likely to be damaged, and may be treated with more liberty: the entering part often can be withdrawn by gentle traction, aided by squeezing from below; and, if adhesions have formed, they may be broken down. Any small necrotic ulcers should be closed by Lembert's suture; but, if they are numerous or extensive, this portion of bowel should be resected. In refractory cases the whole intussusception may be excised; but if the patient is suffering from much shock it may only be possible to perform enterostomy, and hope for the intussusceptum to slough away inside. In recurrent cases the narrow neck may slip back again after reduction, and a length of bowel at that point should be sutured to the abdominal wall to prevent this occurring (Spencer).

Paralytic (*adynamic*) **ileus** is a condition of paralysis of the intestinal muscles, arising from paraplegia, etc. but more commonly as a result of damage to the bowel walls themselves from persistent over-distension with gas or fæces, from partial strangulation with injury to the muscular coats or more especially to the blood-supply, or from peritonitis. It occurs also (rarely) in children as a congenital affection (**idiopathic dilatation**).

The chief **symptoms** are extreme tympanites and meteorism, constipation, and other signs of obstruction of a subacute character,—vomiting, pain, and some collapse.

Treatment.—The gas should be drawn off by a rectal tube retained for several hours at a time. The tone of the intestines must be improved by massage, administration of strychnine, and afterwards by stimulating laxatives. In the more acute cases colostomy may be required. Chronic congenital cases, which resist treatment by regular evacuation with enemas, may be relieved by making an anastomosis between the ascending colon and the rectum.

HERNIA.

Abdominal hernias are either *external*, *i.e.* protrusions of the viscera through the deeper parts of the abdominal wall, or *internal*, which have already been considered. The word *hernia*, though originally meaning only this condition, is used also to denote protrusions of other parts (*e.g.* of brain or muscle); the English "rupture" implies laceration of the tissues, which is not essential, and by no means frequent.

Ætiology.—Hernias are either *congenital* in origin, or are *acquired*. The former are present at birth, or occur soon after, by the entrance of a viscus into a congenital sac left by the non-closure of a peritoneal diverticulum (*e.g.* vaginal process), or through a defect (*e.g.* in diaphragmatic hernia). The layers of peritoneum fail to coalesce, and even if there is no protrusion into the tube, always constitute a potential site of hernia; (and should it fill up with fluid, a *congenital hydrocele* is formed). The *acquired* forms occur after the peritoneal structures have reached their normal development, and nearly always result from continued or repeated pressure on one point of the abdominal wall, where the surface is already dimpled outwards (as at the internal abdominal ring, or at the site of an abdominal scar). Pressure outwards becomes located at this point, and tends to increase the depression until a piece of bowel or omentum can be lodged in it; after which the process is apt to advance rapidly, especially in weakened tissue such as a cicatrix. The most important contributing cause is increased abdominal tension. This may be produced by persistent coughing during an attack of bronchitis; straining to make water, in the endeavour to overcome any existing obstruction to the flow of urine; or straining at stool. It is produced also by violent and repeated exertions, such as lifting heavy weights, and the like. In a few cases a single sudden strain has caused laceration of the tissues and the appearance of a hernia; but this form is rare, and is confined to direct hernias. Most cases, which are apparently of this nature, are sudden protrusions of bowel into a congenitally patent sac which had not been suspected to exist. A *predisposing condition* is accumulation of fat in the body. Small lobules of fat are apt to penetrate the abdominal wall along with vessels, or fill up natural depressions, and as they increase in size, tend to dilate the structures. And if the fat for any reason becomes absorbed, an opening is left through which a hernia readily penetrates.

Pathological Anatomy.—The **opening** in the parietes is called the *mouth*; and it is situated generally at some place where the abdominal wall is thinner and more yielding. If it passes directly through (as in an umbilical hernia), it forms a *ring*; but, if obliquely (as in an inguinal hernia), a *canal*, which is bounded, however, at either end by an internal and external ring. In old hernias this passage may be much dilated, so that a real canal is lost, and is represented by a single wide ring.

The **coverings** vary with the situation; but in all, the different layers tend to be fused together, so that anatomical distinctions are impossible; and the skin is often thinned. The innermost layer of all is the **sac**, composed of peritoneum, continuous with that lining the abdominal cavity. In acquired hernias the sac is pushed in front of the viscera which form the contents. The peritoneum is very elastic, and becomes easily distended; it also develops locally, so as to line a hernia of any size. In all hernias of long standing it becomes considerably thickened and adherent to the surrounding structures. Once the mouth has been passed, the sac dilates and becomes more globular; and it may be divided into separate saccules (*bilocular*, *hour-glass*, etc.) by internal adhesions, or by dilatation against structures of different degrees of expansibility. It may be closed at the neck by fusing of the walls together, or by adhesion of a plug of omentum in the opening; should fluid collect in such a cavity it forms a *hydrocele of the sac.*

The **contents** of hernial sac are usually the small intestine (*enterocele*), (κήλη, a hernia), especially the lower part of the ileum; or the omentum (*epiplocele*), or both (*entero-epiplocele*); sometimes part of the large intestine. The whole diameter of the intestine may occupy the sac, but in rare cases only a portion of its circumference is protruded (*Richter's hernia*), or a congenital diverticulum (*Littré's hernia*). Occasionally the ovaries, tubes, or vermiform appendix are present, or even small loose bodies, originating probably in detachment of appendices epiploicæ. In ventral and other irregular hernias almost any abdominal organ may be found in the sac, even the liver, bladder, or gravid uterus; indeed, the greater part of the abdominal contents may be present in a hernia at one time. Generally speaking, the more mobile the organ, from the length of its attachments and otherwise, the more likely is it to appear in a hernia.

Various Conditions of Hernia.

Reducible hernia is one which can be replaced by manipulation (*taxis*); or which slips back spontaneously when the patient lies down and relaxes the abdominal pressure.

The **signs** of such a hernia are (1) a swelling at the hernial opening, generally soft and elastic, if it contains bowel, but doughy, if omentum; (2) it can be returned to the abdomen, usually with "a slip and a gurgle"; (3) if the tip of the finger is inserted in the ring, the bowel is felt giving an impulse when the patient coughs; (4) if the finger is withdrawn, the hernia tends to follow it down the canal in response to straining; (5) an expansile impulse on coughing is felt when the hand is placed on the swelling; (6) percussion gives a clear note when bowel is present, muffled if covered with omentum, and dull if only omentum or other solid body is present; (7) the swelling is opaque to light, except in some hernias in infants.

Treatment.—**Palliative treatment** consists of reduction of the hernia, and keeping it in place by means of a truss. In adults this support may be left off at night; but if there is any tendency to cough, a light one should be worn, in order to prevent prolapse and strangulation of the hernia during sleep. In all cases where there is a prospect of spontaneous cure the truss must be worn continuously.

False or apparent reduction is pushing back the bowel so that it (*a*) re-enters the abdomen "*en masse*" along with its sac, or (*b*) passes into a diverticulum in the abdominal wall. In either case strangulation is more apt to follow: or if it has already taken place, this manipulation will do little to relieve it. The condition may sometimes be recognised in time by the presence of a palpable tumour in the abdomen close behind the hernial orifice.

Radical Treatment.—In infants under one year the open peritoneal processes tend to close; and if the hernia is prevented from entering, spontaneous cure may be obtained. Hopes of cure are deferred, of course, each time the bowel enters the canal: and this treatment as a radical measure is generally useless after the first years of life. The only other method is by operation; and this should be carried out in (1) all cases of hernia in children who have worn a truss continuously for a year without cure; (2) hernias, even those of large size, in adults, which though reducible give rise to trouble, or prevent the entrance of the patient to certain services, (3) or which cannot be kept reduced by a truss under any conditions likely to be encountered; (4) those which become irreducible, or (5) strangulated, or which from their nature or position are liable to become so.

Operation is contra-indicated (except in cases of strangulation or serious disablement) in the aged, or those over sixty if there is any arterio-sclerosis, bronchitis, or general debility. It is also questionable for very large hernias in patients who are very obese, decrepit from alcoholism, etc. or suffering from any serious organic disease. All such patients bear operations badly, and are specially liable to post-operative pneumonia, a condition which is apt to arise after any surgical measure on the abdominal organs. In others it should be *postponed*, when there is bronchitis or other unfavourable condition, or any skin disease in the neighbourhood of the hernia.

Accidents of Hernia.

Irreducibility.—A hernia may become irreducible from (1) excessive development of fat, either (*a*) located chiefly in the omentum or mesentery after they have entered the sac, so that a club-shaped mass is formed wider than the neck ; or (*b*) in naturally corpulent persons, so occupying the abdominal cavity that the hernia can no longer be returned from want of room. The other causes are (2) inflammatory adhesions in the sac arising from injuries or intermittent pressure of a truss, producing (*c*) fixture of the bowel or omentum to the sac wall, (*d*) coherence of the omentum into a solid mass ; or (*e*) a collection of cysts from accumulation of effusion, or (*f*) entanglement of the hernial contents in bands formed between different parts of the sac ; also (*g*) contraction of inflammatory tissue outside the neck of the sac, or (*h*) in the sac wall itself. The most liable to become irreducible are femoral and umbilical hernias, and those which contain omentum or organs uncovered with peritoneum.

The **signs** of an irreducible hernia are mainly those of a reducible one, which can no longer be replaced. It is generally tenser and more elastic in consistence ; it may vary in size from time to time by entrance of more bowel, etc. and is then often *partially* reducible — the movable part being generally intestine, while the omentum is more likely to be fixed. Dragging on the mesentery often gives rise to nausea and colicky pains ; and if the hernial sac contains large intestine there is usually constipation.

Treatment.—If the irreducibility is due to accumulation of fat, the hernia may again become reducible if the patient emaciates under disease or long confinement. This wasting may be induced also by strict dieting ; and it should be made a preliminary measure before all operations for very large hernias in the obese. Rest in bed, constant elastic pressure, and frequent taxis, help to render it reducible. (**Taxis** is manipulation of the hernia, by steadying the neck with the fingers of one hand, while the fundus is squeezed like a sponge.) If these measures fail, the only other method of cure is operation. If this be refused, *palliative* treatment consists in protecting the hernia with a truss or a belt provided with a hollow cup or a bag, so that further increase is prevented, without pressure on the hernia itself, and therefore without extra danger of inflammation or strangulation.

Incarceration (or *obstruction*) is blockage of the lumen of the intestine in an irreducible hernia. It is confined almost entirely to hernias of the large intestine, as the small gut contains, as a rule, only fluid fæces. It arises generally in costive people, from ingestion of some indigestible food, or from insufficient mastication.

The **symptoms** are those of an irreducible hernia, which gradually becomes larger and harder, and often tender and painful. Constipation becomes established, and general signs of subacute obstructive ileus come on. They differ, however, from those of strangulation in being gradual in onset and milder in character; some flatus may be passed; there is little vomiting or collapse; and the hernia retains some impulse on coughing.

Treatment.—Rest in bed, with no food for the first twenty-four hours, after which the diet must be restricted to digestible fluids as long as the symptoms persist. Purgatives aggravate the symptoms, and may set up strangulation: but enemas may be employed with advantage once the acuter signs abate. Hot fomentations or ice-bags may be applied to the hernia for relief of pain and relaxation of the tissues. Should this treatment be unsuccessful, operation is usually called for; and always if strangulation comes on.

Inflammation, affecting the interior of the sac or its contents (practically a slight local peritonitis), arises readily from irritation by pressure of a too strong or ill-fitting truss, from blows, or even from violent exercise. The omentum being so largely supplied with blood-vessels is liable to stasis from slight compression, with subsequent effusion and adhesion to the surrounding tissues. Obstruction of the bowel in some degree may also give rise to exudation of irritating fluid from the interior. Inflammation here, as elsewhere, may go on to suppuration; but, as a rule, it subsides in a few days. It occurs most frequently in small femoral hernias containing omentum.

The **symptoms** are pain and tenderness of the swelling, which becomes tense and hard. The skin in severe conditions becomes reddened and œdematous. Constitutionally there is usually sickness and malaise, and sometimes rigors and fever.

Treatment consists of rest, with soothing applications and opium to allay pain, and light digestible diet. If suppuration occurs, it must be treated by incision and drainage. When the acute condition has abated, it is advisable to perform a radical cure if there is no special counter-indication.

Strangulation may occur in any hernia at any time, and if unrelieved is usually fatal; it is therefore the chief accident to be feared and provided against. By strangulation in a hernia is implied (1) a firm constriction so that the viscus cannot be reduced, (2) disturbance of the circulation, which may end in gangrene, and (3) if intestine is present, blockage of passage to fæces and gas. The mechanism of strangulation in general has been discussed in connection with *intestinal obstruction*, and little need be added here; but "strangulation" may be met with in a hernia containing omentum alone, the explanation of which is not readily evident. In most cases the *seat of constriction* is at the neck of the sac, and indeed may be caused by the thickening of the sac wall itself, or at least maintained by it after reduction *en masse*. More commonly the actual cause is a sharp edge at one of the rings (*e.g.* at the edge of Gimbernat's ligament in a femoral hernia); sometimes it arises from bands in the interior of the sac. Any increase in the distension by gas aggravates the strangulation, and the condition is thus progressive.

The *parts outside the sac* appear but little changed, unless violent taxis has been employed, when laceration and extravasation of blood may be seen; or unless inflammation or gangrene of the hernia has occurred, when the surrounding tissues may show evidences of taking part in the process. *The sac* may be unaltered, but as a rule it is injected. It nearly always contains fluid, which is generally clear and yellow, and, though irritating, is often free from bacteria; but it may be flocculent or cloudy, and feculent in odour, when it contains amongst other organisms the *bacillus coli*.

The *contents* of the sac are congested; and, if constriction has lasted for some time or has been severe, often gangrenous—the point against which the constricting element has pressed being specially prone to ulceration. If *intestine* is strangulated, the effects are always more profound, owing to the poisonous nature of its contents. In addition, the bowel for some distance above the point of constriction (sometimes several feet) may become congested and œdematous—a condition which occasionally persists long after relief, and may give rise to subsequent atrophy lasting for years. *Omentum* becomes swollen and œdematous, and at last gangrenous; and, even if relieved previous to necrosis, it sometimes forms an inflammatory tumour, which, however, usually disappears in a few months, but may undergo suppuration. *Ovaries*, *appendices*, etc. also may become gangrenous, and give rise to vague symptoms of disorders of these organs.

Another form of strangulation is that known as **retrograde**: it is caused by the free end of a loop of bowel or of omentum projecting back into the abdomen from a hernia, and becoming strangulated at this point, the main part of the hernial contents escaping constriction. The results are apt to be still more serious, as the necrosis takes place in the free abdominal cavity, and toxic absorption, or peritonitis from perforation, is more likely to occur.

The **symptoms** are essentially those of irreducible hernia, along with acute intestinal obstruction of varying degrees. The hernia is larger and tenser than usual, the impulse on coughing is lost, and there is pain at the neck of the sac, gradually transferring itself to the abdomen. In stout people a hernia, if small, may entirely escape notice, especially in cases of Richter's hernia (where a small segment of bowel is caught as a budlike projection and strangulated); and this must be borne in mind in all cases of obscure intestinal obstruction. Gangrene of bowel may sometimes be diagnosed by crackling emphysema under the fingers. The *constitutional signs* of ileus—collapse, tympanites and meteorism, and characteristic vomiting—vary with the hernial contents and the degree of strangulation. The higher up in the intestinal canal, the more profound are the symptoms; while if omentum only is involved, they are rather less marked; but probably even in the last case, and certainly in Richter's or Littré's hernia, constipation and other signs of obstruction may be completely established, doubtless from some reflex action.

Treatment.—**Taxis** should be tried at first for five to ten minutes at most, and always without violence of any kind. It should *not* be attempted if another person has already employed it, or if there is any reason to suspect gangrene or even inflammation of the hernial contents. The chief efforts must be to steady the neck so that the hernia may glide through the narrow mouth; and the parts may be relaxed by hot fomentations or ice-bags. Should taxis fail, the patient must be prepared for immediate operation. If a general anæsthetic is used, taxis may again be employed for *a minute* or so when the patient is under, and the abdomen relaxed. In cases accompanied by profound shock local anæsthesia only should be used.

Continuance of the symptoms of strangulation, after a hernia has been reduced by taxis, arises from (1) incomplete reduction; (2) reduction *en masse*; (3) reduction into a diverticulum of the abdominal wall (especially in inguinal hernias); (4) fresh descent of intestine with recurrence of strangulation; (5) the presence of another hernia, either external or internal, or other intestinal obstruction; (6) reduction of paralysed, or (7) gangrenous or perforated bowel; (8) peritonitis, or (9) enteritis; and (10) effects of an anæsthetic, if used.

Herniotomy implies release of a strangulated or incarcerated hernia, by dividing the constricting edge of the ring. The incision is made at the level of the neck, from the surface downwards, the different layers being picked up with forceps and cut through, until the ring is exposed, when it should be freely divided. In this way there is little danger of internal hæmorrhage from cutting any important vessels which cannot be caught and tied (a likely enough accident, if the tissues are cut blindly on a director from within outwards). The inside of the sac, which should always be opened, is generally recognisable by the presence of a considerable quantity of *hernial fluid*. The hernial contents should always be pulled out a little to make sure that there is no *retrograde strangulation*, and no ulceration at the point of constriction.

If the **bowel** is dark, but glistening and elastic, it is usually *viable*, and should be replaced; and the operation finished, unless the patient is profoundly collapsed, by a radical cure. If the bowel is very dusky and of *doubtful vitality*, it should be drawn out of the ring for a short distance, and surrounded by gauze; the mouth of the hernia, by this time freely divided, well packed round also; and the wound left open. The bowel is examined from time to time, and, if it recovers, is replaced in the abdomen, provided the wound remains aseptic. Should the wound suppurate, however, the bowel should be packed round with iodoform gauze, and replaced just within the abdominal opening (by this time surrounded with adhesions), and the wound allowed to heal gradually by granulations, under free drainage. In such a case, a secondary operation is likely to be required to strengthen the walls. If the bowel is black or grey, dull and sodden, and *obviously dead*, or already perforated, the opening into the abdomen (except in femoral hernias) is enlarged, the bowel withdrawn, a portion resected, and the wound closed. (In femoral hernia the bowel should be well protected with gauze, and drawn out of a *separate* wound in the abdominal wall made for the purpose, and then resected.) When the patient is much collapsed, it may be impossible to do more than make a false anus; the constriction is divided, the loop of bowel brought down and cut across, and fixed in the wound, with a Paul's tube, if available, inserted in the afferent end. The skin should be protected with zinc ointment, as the discharge from an obstructed bowel is often very irritating. A pouch of bowel wall caught in a hernial opening (*Richter's*) is very apt to necrose; if very small it may be covered in with a Lembert's suture; but usually it requires a resection of bowel. *Meckel's diverticulum* should be excised in any case. *Omentum* in a hernia, if healthy and not adherent, should be returned to the abdomen; but, if deeply congested and of doubtful vitality, it should be drawn out and cut across under interlocking ligatures. *Ovaries* if strangulated, or in adults if shrivelled or otherwise diseased, should be removed; but if healthy they should be retained. *An appendix* if diseased should, of course, be excised; but if quite healthy and not adherent to any other structures, it should be replaced in the abdomen.

Treatment of Fæcal Fistula.—If the patient recovers from such an operation, the fistula tends eventually to diminish in size and retract inwards; in which case the wound should be rawed at its edges and closed by suture. If an artificial anus has been made, there is less tendency for it to close spontaneously, though this sometimes happens. It may be encouraged to do so by division of the spur between the afferent and efferent ends of intestine. The blades of an *enterotome* are introduced on either side, and by gradual pressure cause the layers between them first to adhere together on their peritoneal surfaces, and then to ulcerate through. Care should be taken that a loop of bowel is not caught between the two sides of the spur. As this process is often uncertain, it is better in most cases to dissect away the fistulous opening from the abdominal wall, protect the orifice in the bowel with compresses, and withdraw the loop through a fresh abdominal wound, where the fistula is closed, or a portion of bowel resected.

Special Hernias.

Inguinal hernia, the commonest of all, comprises three forms :—

(1) **Oblique**, starting at the deep (internal) abdominal ring, situated in the *external* inguinal fossa and *outside* the deep epigastric artery, (from which it is sometimes called *external inguinal hernia*). It passes down the inguinal canal alongside the cord, and appears at the external abdominal ring, and may enter the scrotum (*scrotal hernia*). *In the female*, it takes the same course, accompanying the round ligament, and may appear in the labium majus (*labial hernia*). If the hernia only penetrates as far as the canal, it makes an incomplete one, and from its appearance is sometimes called a "*bubonocele*."

(2) **Direct**, starting at the *internal inguinal fossa*, just to the inner side of the deep epigastric artery. It penetrates directly through the abdominal muscular wall, and also appears either in the groin, or scrotum.

(3) **Interstitial**, instead of passing completely through the abdominal walls, penetrates between some of the layers; (*a*) between the peritoneum and transversalis fascia (*properitoneal*), corresponding to a hernia reduced "*en masse*"; and (*b*) between any of the layers superficial to this. It is often associated with an undescended testicle. It also sometimes forms part of a *bilocular hernia*, the other part being of the ordinary inguinal variety.

Of the oblique form there are several varieties :—

Congenital hernia depends on the non-closure of the funiculo-vaginal process. Though this remains patent, the upper opening is sometimes so small that hernia does not take place in infancy; but it may still occur (as congenital hernia) at any age, on occasion of a sudden strain. The testis and cord are enveloped and concealed by the hernial contents. Inguinal hernia **in the female** is nearly always congenital, and corresponds to this condition. The unobliterated tube of peritoneum following the round ligament, (called the *canal of Nuck*), may penetrate as far as the labium majus.

Hernia into the funicular process occurs when that is closed below only, *i.e.* just above the level of the testis, while the rest remains patent.

Infantile hernia occurs if the process is closed above only, *i.e.* near the internal ring; and the hernia makes its way behind the unobliterated vaginal process. It differs from a congenital one, in that there are three layers of peritoneum to be divided before the hernial contents can be reached from the front. If the septum be ruptured, the hernia will then correspond to a congenital one.

The **ordinary acquired** form is produced by protrusion of peritoneum and contents into the canal, and down towards the scrotum, lying in front of the testis and cord. Any of these, especially the congenital hernias, may be accompanied by hydrocele of the cord or testis.

The **coverings** of an *oblique hernia* in the complete form are (1) sac, and sometimes subperitoneal fat; (2) infundibuliform fascia, composed of a prolongation of the transversalis fascia in the region of the external inguinal fossa (infundibulum): (3) cremasteric fascia, derived from the lowermost fibres of the internal oblique; (4) intercolumnar fascia, derived from the thin fascia stretching between the two pillars of the ring in the external oblique muscle; (5) deep and superficial fascia, and skin. In the *incomplete form*, where the hernia remains in the canal, the coverings are the same; but the aponeurosis of the external oblique takes the place of the intercolumnar fascia. *In the female*, the cremasteric fascia is absent; but it is occasionally represented by a few fibres of the internal oblique muscle. *In infantile hernia*, the layers of peritoneum in front are trebled; and this is also the case if a *hydrocele* extends upwards in front of an acquired hernia. *In direct hernia*, the opening is well removed from the infundibulum, and that membrane is exchanged for a process of transversalis fascia; further, as it penetrates the internal oblique by separation of the fibres, the cremasteric fascia is not represented at all. Its coverings, therefore, are (1) sac; (2) transversalis fascia: (3) intercolumnar fascia; (4) deep and superficial fascia, and skin. If such a hernia is *incomplete*, it may lie behind the conjoined tendon, which thus forms an additional covering. *In interstitial hernias*, the coverings depend, of course, on what structures are penetrated.

Signs of Inguinal Hernia.—There is swelling in the inguinal region, which may be no more than a small button in the groin (*bubonocele*); or it may fill up and distend the scrotum (or in females the labium). In very large hernias the swelling may be so great that the penis is buried in the mass, and is represented only by an opening at the bottom of a depression, The characters of such swellings have been already discussed. The testicle can usually be distinguished lying behind at the lowest part.

Diagnosis.—In *inguinal hernia* the protrusion is *internal* to the spine of the pubes, and *above* Poupart's ligament; it occupies the inguinal canal; and if reduced gives an impulse to the finger, introduced by invaginating the scrotum; and reduction is effected upwards, outwards, and backwards.

Differentiation between *oblique* and *direct* hernias is seldom possible: but if the deep epigastric artery can be felt, its position to the *outer* side indicates that the hernia is direct; while reduction is effected directly backwards and upwards.

In *femoral hernia*, the swelling lies wholly *external* to the spine of the pubes, and *below* Poupart's ligament, which is often overlapped and obscured by the hernia; the inguinal canal remains empty, and no impulse is given to the finger when inserted; and reduction is effected first downwards, then upwards and backwards.

Hernia is distinguished from *other conditions*, as follows:—

(*a*) *Reducible swellings*, giving slight impulse on coughing. (1) In *congenital hydrocele* the swelling disappears gradually on pressure, or if the patient lies down: but there is no characteristic slip and gurgle; and it may be translucent. (2) In *varicocele*, it disappears in like manner: but re-forms, even if the finger obstructs the inguinal ring; and the dilated veins may be felt like "a bag of worms." (3) In *psoas abscess* the swelling is situated to the inner side of the femoral vessels, it is fluctuant, and is generally accompanied by curvature of the spine: it is not truly reducible, but may alter in size with the position of the thigh. (4) In *varix of the saphena vein* the swelling disappears on compression: the veins at a lower level are generally varicose in addition.

(*b*) *Irreducible swellings*, giving no impulse on coughing. *Upper region.*—(5) In *swollen glands* or *buboes*, there is often an obvious source of irritation; the canal is free; and there may be pain and tenderness, without signs of obstruction. (6) In *lipoma* of the groin the tumour is painless, and often mobile or even pedunculated: and the canal remains free. (7) In *undescended testis*, it is absent from the scrotum; the swelling is elastic, and generally well defined; and pressure on it gives rise to a "testicular" feeling. (If a *retained* testicle becomes *inflamed* or strangulated, the signs are often similar to those of strangulated hernia; and there may be great difficulty in making a diagnosis: but usually there is no constipation; and the local signs of ileus are not pronounced.) *Lower region.*—(8) In *encysted hydrocele of the cord*, the swelling is generally translucent, elastic in consistence, and circumscribed in outline. (9) In *hydrocele of the tunica vaginalis*, the signs are similar: but the swelling is immediately in front of the testis; and begins to form from the bottom. (10) In *spermatocele* also the signs are similar: but the fluid is less translucent, and the swelling is inseparable from the testis and epididymis, which are often found lying above the cyst. (11) In *orchitis*, the swelling is seldom very large, and can usually be defined at its upper limit; and the epididymis can be felt attached as a separate "lobe" to the tumour. (12) In *hæmatocele*, the swelling is tense, elastic, and sometimes fluctuant; there is generally bruising, and discoloration of the skin; and the cord can be felt free above. (13) In *tumours of the testis* (*tubercular*, *syphilitic*, or *neoplastic*), the swelling is often unusually heavy and solid; and the cord above, as a rule, is free.

Treatment—Palliative.—The only reliable way of retaining an inguinal hernia is by a spring *truss*; the efficiency of skeins of wool, or spica bandages and pads, being usually quite illusory. The spring should extend from the inguinal ring, round the pelvis, to opposite the anterior spine of the other side: it is continued by a strap which is buttoned to the pad: and this is the measurement to be given with other particulars to the instrument maker. It should lie midway between the crest of the ilium and the trochanter; and be kept in this position by the under strap. The pad should be small enough to rest on the soft tissues only, without bearing on the pubes; and large enough to avoid invaginating the coverings into the ring. For bathing, and for childrens' use, it should be covered with rubber. Irreducible hernias are treated with a *cup-* or *bag-truss*. All sources of straining must be treated. Children with phimosis should be circumcised, and care should be taken to separate the foreskin if adherent: this must be a preliminary to any radical operation.

Radical treatment is performed by reducing the hernia, separating the sac, and cutting it off, or displacing it inwards, so as to remove the "pouching" of peritoneum from the weak spot on the abdominal wall; (*Czerny's*, *Banks's*, and others' operations). The first step in all the operations is reduction of the hernia if possible, and exposure of the sac, which should be opened, in order to ensure that all adhesions inside are separated. Ovaries or appendices, *if undamaged*, should be returned. The closure of the openings is made in various ways.

Macewen's operation.—The sac is separated from the cord, and for half an inch around the internal ring, without division of the external oblique. A stitch is fastened to the fundus, and passed zig-zag through the rest of the sac, emerging at the neck, and then brought out through the anterior abdominal wall just above the internal ring; by pulling on the suture and guiding with the finger in the canal, the sac is folded on itself, to form a pad inside at the level of the ring, where it is retained by fixing the end of the suture at this place. The internal oblique and transversalis muscles are drawn down below the edge of Poupart's ligament, and fixed by mattress sutures; and the wound is closed. In *Stanmore Bishop's modification*, the sac is invaginated on itself, and fixed as in Macewen's operation.

In *Kocher's operation* the neck of the sac is displaced, and the external oblique not divided. (*a*) *Lateral displacement.* After the sac is isolated and separated, a small puncture is made in the anterior abdominal wall a little to the outer side of the deep ring. Through this a dressing forceps is inserted and passed down the canal, where it catches the tip of the sac. The whole sac is drawn out at the opening, the neck sutured in place, and the rest cut off. The canal is obliterated by a mattress stitch folding the two pillars of the ring together, ("*gutter suture*"). (*b*) In *invagination displacement* the tip of the sac is first caught in the point of the forceps, invaginated into itself and passed up the canal into the abdominal cavity; thence it is forced through a minute opening in the abdominal wall, pushing before it the peritoneum, which it penetrates after it has been incised. The neck of the sac is sewed to the peritoneum, and dropped back, after cutting the rest off short; and the operation is finished as before.

Bassini's operation consists in remaking the canal for the cord. The external oblique is split, and widely separated on either side from the underlying layer, and the flaps turned back. The cord is lifted out on a blunt hook, and the sac separated, and cut off under ligature. The muscular edge of the internal oblique and transversalis is united to Poupart's ligament beneath the cord, leaving room for its exit at the upper end. The external oblique is then sutured over the cord, which has been replaced in a more superficial position, and the wound is closed. This operation is specially useful for large hernias in adults, and in recurrent cases; while the foregoing are more suitable for small hernias, and in children. *Girard*, in large hernias with very relaxed abdominal walls, proceeds in the same way; but sews the inner edge of the external oblique also to Poupart's ligament, while the outer edge is overlapped for an inch or more, and fixed in position. *Halstead's operation* is a modification of Bassini's, in which he places the cord superficial to the external oblique.

For deep sutures, at all events, strong absorbable material such as chromic gut or reindeer tendon should be used. The most useful dressing, especially for infants, is a small gauze and collodion covering, without wadding or bandages; the wound can thus be kept dry and clean, and inspected from day to day. The patient should be kept in bed for three weeks; and, on rising, should gradually begin gentle exercises to strengthen the abdominal muscles. (Some surgeons induce the wound to heal with profuse granulations, by keeping it open, in order to obtain a dense scar; but this method is generally condemned as unsurgical.) No truss or elastic bandage should be worn after recovery; except when the hernia recurs.

Femoral (*or crural*) **hernia** is much less common than inguinal; and is less frequent in males than in females. It consists of a protrusion through the *femoral or crural ring*, lying between the femoral vein and Gimbernat's ligament. Normally that is backed by a collection of fat and a lymphatic gland (of Rosenmüller), lying in, and surrounded by, a compartment of the femoral sheath, (the anterior layer of which forms the "*fascia propria*"). The protrusion of a hernia through this ring as far as the cribriform fascia, at the saphenous opening of the fascia lata, produces a *real femoral canal*.

The **coverings**, therefore, of such a hernia are: (1) sac, and sometimes subperitoneal fat; (2) septum crurale; (3) fascia propria; (4) cribriform fascia; (5) deep and superficial fascia, and skin. The loose tissues in the canal are pushed aside; and the various layers are generally fused together.

The *internal ring* is formed by the sharp edge of Gimbernat's ligament inside, Poupart's ligament in front, the inner septum of the femoral sheath outside, and the pectineal line and fascia behind. The *external ring* is made by distension of the cribriform fascia to form a *true saphenous opening*, the lower border of which is firm and falciform. The chief situation of constriction is at the neck against Gimbernat's ligament; but it also may be at the saphenous opening, at which point the hernia is generally bent acutely upwards. The obturator artery is occasionally given off irregularly from the deep epigastric artery, and it may pass down on Gimbernat's ligament at the inner side of a femoral hernia; but usually it keeps to the outer side.

Signs.—There is a swelling in the groin lying below Poupart's ligament, usually tense, globular and not very large; and extending upwards and outwards from the saphenous opening. The characters are those of hernias in general.

Diagnosis.—Femoral hernia is diagnosed from other hernias as above. But it may be confused with *enlarged glands*; with *varix* of the saphenous veins; and with *psoas abscess*.

Treatment.—*Palliative treatment* is by truss, which should be kept from riding up by an under strap encircling the upper part of the thigh. To reduce a femoral hernia by taxis, the thigh should be flexed, in order to relax the fascia lata. If the hernia becomes *strangulated*, it must be exposed down to the neck, and Gimbernat's ligament incised by small nicks upwards and inwards. Should an aberrant obturator artery be wounded, and not accessible for ordinary ligation, it should be controlled by suture-ligature.

Radical treatment consists in returning the hernia, cutting off the bulk of the sac, closing the neck by ligation, and fixing it (as in Kocher's inguinal operation) above the ring. The opening may be closed by inserting a suture between Poupart's ligament and the pectineal fascia. If the opening be wide and lax, it may be efficiently closed by *Roux's method* of pinning down Poupart's ligament, by a small staple driven into the pubes, until it almost touches the bone; the main obturation being kept up later by the inflammatory cicatricial tissue surrounding the staple.

Umbilical hernia occurs in three forms.

(1) **Congenital**, or **hernia into the cord**, is more properly classed as a defect of the abdominal wall. It may take place into the cord itself, or just above it. The contents are anything from a small knuckle of bowel, to the greater part of the abdominal viscera (*ectopia viscerum*). The *covering* is a

transparent membrane composed of peritoneum and umbilical cord.

Treatment.—In small hernias, the surface should be cleansed and disinfected, and covered with antiseptic gauze, while the contents are kept reduced by pressure. Large hernias are usually soon fatal from sloughing of the delicate covering, and infection of the peritoneum.

(2) **Hernia of infants** forms after the navel has cicatrised. It is encouraged by straining, due to crying, coughing. difficult urination, or constipation. The small umbilical ring becomes stretched, and, once a loop of bowel enters the pouch, dilatation proceeds rapidly for a time: but the hernia seldom grows bigger than a walnut. The *coverings* are sac, transversalis fascia (sometimes also a few fibres called "*umbilical fascia*"), and skin. If the source of straining is removed, the hernia tends to cure itself spontaneously as the child grows; this may happen up till about the age of puberty, and for that reason, operation is seldom required.

Treatment.—The hernia should be kept reduced from the first, by means of a firm pad bound over it with adhesive (zinc) plaster: the pad being at least half an inch wider than the ring, to avoid penetrating and dilating the opening. Or the skin may be pleated into two folds concealing the hernia, by means of plaster strapping. If cure does not result by about the age of fourteen, a radical operation should be performed.

(3) **Hernia of adults** occurs most commonly in women. It arises mainly from stretching of the parts, and is therefore met with chiefly in those who have borne many children; or in the obese, especially those who have begun to emaciate rapidly. The hernia often grows to great size, and is sometimes flattened out on the abdominal wall beneath the skin. The *coverings* are only sac, transversalis fascia and thinned skin. The *contents* consist generally of omentum and bowel; and from their exposed position they are very liable to irritation, leading to adhesions of the contents to one another and to the sac, and also to the formation of various septa and loculi, in any of which a piece of bowel may be caught. Such hernias therefore are usually incompletely, or not at all, reducible. *Strangulation* is very apt to occur, and is always a grave condition: some bowel is nearly always included. Patients with umbilical hernia are often extremely fat, and are therefore bad subjects for operation, and especially for general anæsthesia; and do not

bear well the subsequent recumbency. On account of the very general tendency to delay in calling in a surgeon, these cases are often very unfavourable for treatment.

Symptoms.—There are often colicky pains, vomiting and constipation, and occasionally impaction of fæces; and the habitual recurrence of those attacks often masks the commencement of real strangulation. Sometimes a small hernia may not be apparent, until recognised by its reduction with a slip and gurgle.

Diagnosis.—The chief source of confusion is a lipoma, which usually gives no other signs of hernia but its swelling.

Treatment.—*Palliative treatment* is often the only one permitted, until some complication comes on. The hernia, if reducible, should therefore be controlled by a pad truss; or, if irreducible, by a hollow pad in a supporting binder. *Radical treatment* is indicated in all cases, especially if irreducible, where the patient is in a fit condition to stand operation; and always after herniotomy for strangulation, unless the patient is too ill.

Operation.—For strangulation, or as a preliminary step of radical cure, an incision should be made perpendicularly at the side of the hernia. It is carried into the abdomen about half an inch from the ring. The edge of the wound bearing the hernia is turned outwards, and the hernia drawn out from within, or if adherent dissected out of the sac. This method is much easier and quicker than making an incision over the hernia and dissecting downwards. Adherent omentum should be tied and cut away. *Radical treatment* is completed by continuing the incision up and down, curving it towards the middle line above and below, and repeating the same on the opposite side, so that the hernial coverings are removed along with the inner part of the sheath of the rectus muscle of each side. The edges of the wound are now sutured together in layers,—posterior sheaths of recti, muscles, anterior sheaths, and skin,—so as to make a firm abdominal wall (*Gersuny's operation*). The skin incision is often made transversely, and the flaps retracted to allow of the later manipulations.

Ventral hernias may arise in any part of the abdominal wall. Those in the middle line arise from the consequences of a subperitoneal lipoma dilating the interstices of the interlacing fibres of the linea alba, generally above the umbilicus (*vide* p. 370). They also arise in any old scar, especially after suppuration of an abdominal wound. They resemble in most respects the umbilical hernias of adults; and are *treated* practically in the same way. If they are situated in the flanks the muscular layers are of course different, but the method of union is similar.

Among the rarer hernias are :—

Lumbar hernia occurring in the posterior abdominal wall, generally in the *vicinity* of Petit's triangle.

Obturator hernia, penetrating the obturator foramen alongside the obturator vessels, and appearing in front of the thigh. It is *diagnosed* by the depth of its situation; and occasionally by severe pain along the inside of the thigh down to the knee, from pressure on the obturator nerve.

Gluteal hernia, passing out with the gluteal vessels, and **sciatic hernia**, with the sciatic vessels, each penetrating the sacro-sciatic foramen, and appearing in the buttock.

Perineal hernia protruding through the floor of the pelvis, and presenting alongside the anus. It sometimes appears in the perineum along with a mal-descended testicle (*inguino-perineal*); and occasionally in connection with a prolapse of the rectum (*prolapse-hernia*).

Treatment.—As these hernias are often impossible to diagnose correctly, and in any case difficult to deal with by external operation, the treatment is generally by laparotomy. The hernia is withdrawn from within, as in "internal hernias," and the opening closed or covered by means of mattress sutures, with plastic incisions where the situation permits.

LIVER AND GALL-BLADDER.

For **injuries**, *see* page 386.

Abscesses of the liver, (apart from multiple abscesses of metastatic origin, which are little amenable to surgical treatment), occur singly from (*a*) special infections associated with amœbic dysentery (*tropical abscess*); (*b*) suppuration occurring in a hydatid cyst; (*c*) and spread of a perihepatic abscess, (following suppuration of the gall-bladder, ulcer of the stomach, etc.).

The **symptoms** are mainly those of subacute suppuration; but are apt to be ill-defined, and obscured by the primary conditions, such as dysentery, or indigestion. The *tropical* form is the most common, and is somewhat chronic in character, varying in duration from three to thirty months or more. There is usually fever accompanied by rigors, which may easily be mistaken for malaria. The skin is often yellowish, but true jaundice is rare. If dysentery is present, amœbæ may be found in the stools. The liver is enlarged, and may encroach on the diaphragm and pleural cavity; and the lower border often projects and is displaced downwards. This enlargement may also cause pressure on the portal vein, and give rise to œdema, or to dilatation of the superficial veins ("*caput medusæ*"). Pain as a rule is absent, but there is general discomfort, and digestive troubles are common. The other abscesses have usually more acute and localised signs. If an abscess ruptures into a hollow viscus, there will be considerable relief of the symptoms; if into the peritoneum, there will be peritonitis.

Diagnosis.—From *multiple abscesses*, where the local signs are less pronounced; *subphrenic abscess*, where the origin is more likely to be apparent; *hydatid cyst*, where the walls are tense, and fever is absent; *empyema of the pleura*, where the dulness extends further upwards on the chest, and the lower edge of the liver retains its shape; *empyema of the gall-bladder*, with history of "gall-stones" and possibly jaundice; *hydro-* or *pyonephrosis*, with stoppage of the flow of urine from one side, and sometimes periodic disappearance of the tumour, or with pus in the urine; *cysts* or *abscesses* of the *pancreas*, *mesentery* or *spleen*, with more obvious limits to the swelling, or different relationships to the stomach. In many cases the diagnosis is easy, but in others it is sometimes impossible without laparotomy. Aspiration for the purpose of diagnosis is extremely dangerous, and should be replaced by free incision under proper precautions against infecting the peritoneum.

Prognosis varies with the origin of the abscess. If the abscesses are multiple, it is very unfavourable. Solitary abscesses, even after operation, are said to have a mortality of 50 per cent. In rare cases they become encapsuled and absorbed.

Treatment.—If adhesions have formed with the abdominal wall, the abscess may be opened at once, and all the pus washed out with saline solution. If there are no adhesions, the liver must be packed round with compresses, the bulk of the fluid drawn off by aspiration, the opening enlarged, and the cavity wiped out with gauze, without irrigation. The orifice in the liver should be drawn up to the external wound and sutured to it. Drainage in both cases is carried out through a very large rubber tube, with sterile gauze packed round it and the wound. Iodoform should be used in small quantities only, as it is readily absorbed here. If time admits, the opening may be made in two stages: the first to cause adhesion to the abdominal wall either by suture or packing round with gauze, and the second, ten days or so after, to open the abscess. If the abscess is in the upper surface of the liver, it is often more convenient to open it *transpleurally*, with resection of one or two ribs.

Hydatid cysts are due to infection with *tænia echinococcus* (*vide* p. 53).

The **symptoms** are often absent until the cyst distends the liver, or forms a round elastic tumour itself. There is seldom pain; and fever is usually absent unless suppuration occurs, when other signs of abscess may be present. Unless it is very tense the swelling generally gives rise to fluctuation accompanied by a "thrill." Pressure upwards on the diaphragm may cause cough and dyspnœa, or oppression of the heart; pressure on the kidney may produce intermittent albuminuria. As the cyst reaches the surface adhesions may be formed, sometimes giving rise to dragging sensations, but acting as a safeguard in the event of rupture. If rupture does take place into the alimentary canal, relief usually follows, at least until the sac becomes infected; if into the peritoneum, urticaria rapidly appears; while, if the cyst is purulent, there will be peritonitis. If it ruptures into the lung, after penetrating the diaphragm and pleura, it usually causes death (with symptoms of pneumonia).

Diagnosis.—Hydatid cyst of the liver may have to be differentiated from that of the pleura or lung; also from tumours or general enlargement of the liver; and from abscesses, and all those conditions which resemble them.

Treatment.—The cyst is treated in the same way as an abscess, in one or in two stages, or by the transpleural route. In a few cases it may be possible to dissect out the cyst entire, and thus avoid the danger of infecting the peritoneum. Failing that, the inner wall should be drawn out. If too adherent, it should be left to separate, as a considerable flow of bile often results from pulling it away before it loosens. Any deeper cyst may be opened through the cavity of the first one. The wound is drained with large tubes, and the peritoneum protected with packing; and if possible the opening in the liver should be fixed to the aponeurotic layer of the abdominal wall by suture.

Tumours of the liver are seldom amenable to surgical treatment; primary tumours are not common, and are seldom diagnosed until late: and secondary ones are beyond the possibility of extirpation. *Gummata* should be treated by medical means only. Pedunculated *adenomata* may be cut away, with ligation of the pedicle. *Imbedded tumours* may sometimes be excised along with a wide margin of sound tissue, with deep ligation of the tissues in front of the cut by means of a large blunt needle. The incision should be made V-shaped if possible, so that the surfaces may be brought together to control hæmorrhage. The wound should be packed with gauze leading down to the incision, with a view to drainage, should internal hæmorrhage take place.

Cholelithiasis—Cholecystitis.

Gall-stones are formed chiefly of cholesterine, sometimes of calcium salts and bilirubin; occasionally there is a foreign body (thread worm, etc.), forming a nucleus round which the calculus develops. They are usually smooth and round, and if multiple, facetted on the sides in contact with one another. The colour is generally brown or yellowish, depending to some extent on the amount of bile pigment. Their formation is attributed to heredity, unsuitable diet, etc.; but they are undoubtedly encouraged by any obstruction to the flow of bile, and are often, if not always, preceded by catarrh of the biliary passages, which in most cases is due to infection spreading from the alimentary canal. Unless inflammation of the gall-bladder takes place, or the flow of bile is interfered with, calculi may exist without giving rise to any symptoms. As soon as a gall-stone passes into the common duct, jaundice develops and continues until the stone passes into the duodenum, or until the duct dilates and allows the bile to flow past. If dilatation is long continued, the walls become indurated and rigid. In some cases ulceration takes place, and this happens more frequently if the stone is impacted in the *ampulla of Vater*, whence it sometimes perforates into the duodenum. The distension of the bile ducts is apt to set up **cholangitis** in the liver, giving rise to fever and rigors resembling ague; and sometimes going on to suppuration: and if repeated often, causing wasting and loss of strength. The constant irritation of a stone in the gall-bladder may predispose to *cancer*. If jaundice be long continued, it may cause cirrhosis of the liver, or act injuriously on the blood-vessels, inducing hæmorrhages.

Cholecystitis (*inflammation of the gall-bladder*) arises by infection with *bacillus coli* or other bacteria from the bowel, especially in the presence of gall-stones, or even hydatids, ascarides, or tumours. It also arises in connection with typhoid fever, influenza, etc. It may be merely *catarrhal* (often producing ropy mucous secretion), or *purulent*, or even *phlegmonous*, leading to perforation. The latter form depends largely on thrombosis of the cystic vessels as well as bacterial infection. If the cystic duct becomes blocked by cicatrisation, or by a calculus, and if the inflammation subsides, a mucous dilatation (*hydrops*) of the gall-bladder results; but if the inflammation continues, *empyema of the gall-bladder* is produced. Associated with dilatation of the gall-bladder there is sometimes a *tongue-shaped lobe* (*of Riedel*) produced in the part of the liver immediately above the gall-bladder, either from traction, or some other cause.

If the calculus becomes loosened, or falls back into the gall-bladder like a ball-valve, or if it passes down into the duodenum, the inflammation will abate and the symptoms subside; but in many cases the attacks recur from continuation of the infection, and from the thickening and rigidity of the gall-bladder walls which prevent it from being emptied. If long continued, the inflammation spreads to the outside of the gall-bladder (*pericholecystitis*); and causes kinking of the ducts, or adhesions to the pylorus or duodenum, and sometimes stenosis of those structures. If a gall-bladder adheres to the duodenum or colon, and ulceration takes place at the point of attachment, it will discharge its contents into them, and may so induce a spontaneous cure. Discharge into the stomach in this way is much less common. Inflammation may also spread to the neighbouring structures, and produce thrombo-phlebitis (*pylephlebitis*) of the portal vein, and diffuse cholangitis, or hepatic abscess. It may also spread along the ducts to the pancreas, and set up thickening of the head of the pancreas to form a hard tumour, a suppurating pancreatitis, or (by pressure on its ducts) a cystic dilatation.

Perforation of a suppurating gall-bladder, from ulceration of a calculus or otherwise, if slow and gradual, may give rise to sub-hepatic abscess; but if sudden, to suppurating peritonitis.

Symptoms.—In *obstruction from gall-stones* there is pain and tenderness in the right hypochondrium, due partly to inflammation, and partly to muscular spasm. When impaction (even of inspissated mucus) occurs in the ducts, the pain is specially severe, (**biliary colic**), causing colicky cramps, collapse, and vomiting; and this continues until the concretion is loosened or passed. If the *cystic duct* alone is blocked, there will be distension of the gall-bladder, giving rise to a rounded tumour, which can often be made out below the border of the liver; and occasionally a tongue-shaped lobe can be detected above it. If the *common duct* is blocked, there will be jaundice as well. If only the *hepatic duct* is blocked, there will be jaundice, and often fever and chills, but no distension of the gall-bladder.

With *inflammation of the gall-bladder* there are aching pains, fever, and sometimes signs of localised peritonitis. There is occasionally jaundice; but if neither the common nor hepatic ducts are obstructed by stones or inflammatory thickening, it will not be manifest. In *empyema of the bladder*, it is distended to form a palpable tumour: unless shrivelled so much by previous inflammation that it is retracted below the border of the liver.

Diagnosis.—*Jaundice* may be due to obstructive causes—(1) gall-stones and other foreign bodies; (2) cicatricial contraction or kinking of the common duct; (3) inflammatory tumefaction of the duodenal papilla; (4) pressure of a tumour closing the orifice; or it may be due to (5) catarrh of the bile ducts in the liver; (6) specific infections, such as yellow fever; or (7) certain poisons, such as phosphorus.

Biliary colic may be mistaken for that of a renal calculus, or intestinal obstruction. *Dilatation of the gall-bladder* for a tumour, or a movable kidney. *Suppurating cholecystitis* for appendicitis, typhoid fever, malaria, or septicæmia; and the *phlegmonous* form, for rupture of the stomach, bowel, or appendix, with peritonitis.

Treatment.—Patients subject to mild attacks of cholelithiasis should undergo periodical treatment with Carlsbad or other similar waters. When an acute attack comes on, the patient should be put to bed, hot fomentations may be applied to the abdomen, and morphine administered to alleviate pain and spasms. This treatment should be continued unless symptoms of cholangitis come on, with fever, loss of appetite, etc., or of suppuration in the gall-bladder or ducts, with rigors and sweating. If those acute conditions appear, the gall-bladder should be opened and drained without delay, **(cholecystostomy)**. Gallstones in the hepatic duct seldom require operation, but if impacted for long they are apt to induce cholangitis, in which case it may be necessary to cut down on them, if they cannot be extracted otherwise.

Operation is indicated for (1) relief of chronic and recurrent attacks of biliary colic or cholecystitis, which generally tend to become more frequent and severe in spite of medical treatment; (2) acute attacks, as above; and (3) where there is a suspicion of carcinoma.

Cholecystotomy, or opening the gall-bladder for removal of stones, or for other purposes, is performed in one stage; or in two, with preliminary adhesion to the abdominal wall. The first method is more useful, as it permits a full exploration of the ducts as well as the gall-bladder from the outside. The abdomen is well packed round with compresses, the fluid is aspirated from the gall-bladder, which is afterwards opened up and wiped out. Stones are removed by blunt spoons, and if situated in the ducts, pressed out by the fingers. The common duct is explored with a blunt-pointed probe to make sure that the passage is free, otherwise the operation is of little value. In almost all cases it is better not to close the opening in the gall-bladder by suture (*cholecystendysis*), but to sew the opening to the deep (aponeurotic) layer of the abdominal wall, and drain it with large tubes and gauze packing (properly, *cholecystostomy*). If a gall-bladder is sewed to the *external layers*, a fistula is very apt to remain when the rest of the wound has healed.

If a stone cannot be extracted from the cystic or common duct, it should *not* be crushed from without, as has been advised, as the duct walls are apt to be damaged and afterwards stenosed. The wall should be incised **(choledocotomy)** over the stone, the stone removed, and the incision sewed up by Lembert's suture. Gauze packing should be inserted down to the wound in the duct, as it is not always possible to make it water-tight. The gall-bladder should be opened in these cases, and to perfect the drainage, a tube may be inserted into the hepatic duct and led out of the wound (*hepatic drainage*). The ducts and gall-bladder can be exposed much more easily if a narrow sand-bag is placed beneath the patient, about the level of the last ribs. If the gall-bladder or cystic duct is kinked, shrivelled or diseased, it should be removed (**cholecystectomy**); if it is left, stones are apt to form again, inflammation recur, or cancer develop in its walls; indeed many surgeons hold that this should be done in all cases of cholecystitis which require operation. Should the common duct be constricted by adhesions or by external pressure, the gall-bladder should be *anastomosed* to the duodenum (**cholecyst-enterostomy**), by a small Murphy's button, or better still, if possible, by plain suture. If the duodenum is not available for anastomosis, it may be attached to the jejunum; but only in exceptional cases, where there are dense adhesions, to the colon.

In all those cases care should be taken not to include the mucous coat in the suture of the gall-bladder or duct, as gall-stones are apt to form around any unabsorbed thread. As complete closure of the external wound is dangerous, a few sutures should be inserted, but a strip of gauze should always lead down to the gall-bladder or duct and partly surround it. When drainage is given up, the wound soon closes, unless there is still an obstruction to the flow of bile.

After-treatment.—Should a (**biliary**) **fistula** remain, discharging bile and irritating the skin, it is generally due to continued blocking of the common duct. It should be explored with a flexible probe to see if the passage can be dilated; if not, the proper treatment is *cholecyst-enterostomy*. A purely mucous discharge generally indicates that the common duct is patent, but that the wound is prevented from closing by protrusion of the mucous membrane into the wound. The edges of the opening should be cauterised or excised, and the lining membrane scraped out.

Tumours of the Gall-bladder.—*Papillomata* occur but rarely in the gall-bladder. *Cancer* is more common, and is generally preceded by cholelithiasis. If it is diagnosed before the liver has been involved, which is not often the case, the gall-bladder should be excised.

PANCREAS.

Interference with function gives rise to disturbances of the various secretions of the pancreas,—(*a*) proteolytic, (*b*) amylolytic, (*c*) milk-curdling, and (*d*) lipolytic ferments; (*e*) ferments which, among other properties, split up salol into salicin and phenol; and (*f*) an "internal secretion" (confined chiefly to the "*islands of Langerhans*") which, even in small quantity, seems to prevent the occurrence of glycosuria.

Inflammation may arise from injury, from general infective diseases such as typhoid, from inflammation spreading from the stomach, duodenum or gall-bladder; or from bacteria passing in from the healthy alimentary canal, or even from bile entering the pancreatic duct, especially if the pancreas is predisposed to inflammation by obstruction, and retention of its secretion.

Three forms of pancreatitis are recognised: (1) acute, in which there is great softening, and, on account of the abundant blood supply, diffuse hæmorrhage (*hæmorrhagic pancreatitis*); (2) subacute, resulting generally from infection secondary to inflammation elsewhere, and generally going on to suppuration: (3) chronic, in which the interstitial tissue especially is increased and forms a hard tumour.

Acute Hæmorrhagic Pancreatitis.—The **symptoms** are sudden severe pain in the epigastrium, collapse and vomiting; tenderness and gradual swelling above the umbilicus. The temperature is variable, but often subnormal at first, rising afterwards if the patient survives. The pulse is rapid and small, the face is anxious and pinched, and there is extremely rapid loss of weight. There may be constipation, but flatus is usually passed. The progress of the disease is generally so rapid that little information can be obtained from the source of pancreatic function.

Diagnosis.—It closely resembles *rupture of the stomach* or *gall-bladder* with peritonitis; but there are no precursory signs of ulcer or gall-stones. *Intestinal obstruction* is also similar: but the swelling and distension in such cases is much greater, and flatus cannot be passed. In *appendicitis* with perforation the pain at first is referred to the iliac region or the umbilicus, instead of being confined to the epigastrium. In *biliary coliac* there is often jaundice, and the local tenderness and swelling are not so pronounced. Some of these conditions may accompany pancreatitis, and lead to great confusion. In cases of doubt an exploratory incision is indicated, unless the patient's condition is desperate.

Prognosis.—Acute pancreatitis is extremely fatal, and if operation does not relieve the symptoms, it ends in death in from two to five days.

Treatment is practically that of local peritonitis beginning in the lesser omentum, (with which it is often accompanied), viz. drainage. Morphine is required for the severe pain, and stimulants for the collapse. When the abdomen is opened, evidences of *fat necrosis* are at once seen,—small particles of soapy or chalky material scattered in the omentum and mesentery; they are due to the splitting up of the fat into glycerine and fatty acids, the former being absorbed, and the latter precipitated with calcium salts.

Subacute pancreatitis may begin as suddenly, or more gradually, but is never so severe, and the inflammation generally goes on to suppuration. The pulse is less rapid, the temperature is high and febrile; rigors are not uncommon, and the pain occurs partly continuously and partly in paroxysms. Diarrhœa comes on, with bloody and foul-smelling stools; and the patient rapidly loses flesh and strength. Albuminuria is common; but glycosuria and lipuria are rare. If an abscess forms it projects in the superior abdominal region, generally between the stomach and colon, but occasionally above the stomach or below the colon. It has been known also to pass down on the psoas to the iliac region.

Prognosis.—Subacute pancreatitis is still a very dangerous disease, but rather less frequently fatal than the hæmorrhagic form.

Treatment.—Morphine should be administered for the pain and collapse; and the bowels should be evacuated with calomel and enemata. The abscess may be approached from the front through a median incision, and evacuated under the same precautions as a liver abscess, the gastro-colic omentum here being an additional protection. A drainage tube should be passed through the posterior wall in the costo-vertebral angle; indeed, if a pancreatic abscess is clearly diagnosed, it should be approached and drained entirely from behind.

Chronic pancreatitis arises from the spread to the pancreatic ducts of irritation from gastro-duodenal catarrh or ulceration; from biliary lithiasis; or, very rarely, from subsidence of an acute attack. The connective tissue increases, and generally gives rise to a hard tumour, accentuated about the head of the gland, which may be mistaken for cancer. Contraction of this tissue causes pressure-atrophy of the parenchymatous cells; and if the common bile duct is deeply imbedded in the pancreas, it becomes obstructed.

The **symptoms** are wasting, with loss of appetite and dyspepsia, and occasionally vomiting; paroxysmal pain in the epigastrium, and tenderness below the gall-bladder. If the common bile duct is involved there is jaundice, and ague-like fever and rigors. Even with the presence of bile in the alimentary canal, the stools may be clay-coloured. There is generally diarrhœa, and very frequently albuminuria. Glycosuria does not appear unless the islands of Langerhans are profoundly atrophied (a late effect); and then there are generally other signs of diabetes,—polyuria, and sometimes bronzing of the skin. Fat is present in the stools, and the fæces contain undigested muscle fibre, if the patient is getting meat diet. Salol is not decomposed, and therefore does not appear in the urine as salicin and phenol (*Sahli's sign*).

Treatment.—The obstruction should be relieved if possible:—gall-stones should be extracted from the ampulla of Vater, inflammation of the papilla or pressure of a distended duct should be relieved by *cholecyst-enterostomy*. As the anastomosis is apt to close, a simple *cholecystostomy* has been found to give better after-results in some cases.

Pancreatic cysts are rare on the whole. They may arise, generally after middle age, as the results of effusion following an injury, or subsidence of a hæmorrhagic inflammation. *Retention-cysts* are due to (*a*) blocking of the duct of Wirsung by a stone in the ampulla, along with absence or obstruction of the accessory duct (of Santorini); (*b*) cicatrisation of the duodenal papilla following ulceration; (*c*) external pressure; (*d*) closure of the smaller ducts in the body of the gland from interstitial inflammation; (*e*) dislocation and kinking of part of the gland. *Proliferation-cysts* arise from degeneration of adenomas or carcinomas, from congenital cystic disease, or from hydatids. Cysts in the lesser omentum arising from other sources may be mistaken for these (*pseudo-cysts*).

The **symptoms** are usually absent while the cyst is still small. As it grows, pressure signs ensue; and a tumour which is generally well defined, tense and elastic, appears in the same place as does a pancreatic abscess. The general health always suffers,—wasting and weakness, with sallow, pinched, and anxious appearance. There are fatty stools; and Sahli's sign is obtained if the gland is much destroyed, but glycosuria, only if the atrophy is extreme.

Diagnosis from distension of the gall-bladder, cysts of the ovary, liver, suprarenal capsules, or spleen; hydronephrosis and cysts of the kidneys; cysts of mesentery, omentum, and retroperitoneal tissue.

Treatment.—If the cyst is encapsuled, it may be possible, in a few cases, to extirpate it completely. As a rule it must be evacuated and drained like an abscess.

Tumours.—**Carcinoma** affects chiefly the head of the pancreas. It is insidious in onset, and the *symptoms*, when they appear, are digestive disorders; severe pain in the epigastrium, radiating round the body, and ultimately becoming almost intolerable; and nearly always jaundice. Swelling is not evident until the later stages. A certain amount of pancreatitis accompanies cancer; and depending on this, and the destruction of the gland by the tumour, are the special symptoms of pancreatic atrophy, viz. fat necrosis, glycosuria, and Sahli's sign. *Treatment* is purely symptomatic.

Adenomata, *sarcomata*, and *other tumours* are very rare.

SPLEEN.

Abscess may arise from infarction in the course of infective diseases; as a result of chronic malaria; or even of injury.

The **symptoms** are indefinite, but there is enlargement, and the signs of suppuration, and *perisplenitis* (peritonitis and sometimes pleurisy), often give an index to the condition.

Treatment.—An incision is made in the left flank under the 11th rib, the abscess evacuated and drained, or if the spleen is much destroyed, the whole organ excised (**splenectomy**), with accurate ligation of the vessels.

Enlargement of the spleen is due to simple hypertrophy, repeated attacks of malaria, or tuberculosis; and also to hydatid cysts, and (rarely) to primary tumours.

Symptoms are dragging pains, pressure effects, and toxæmia, giving rise to fever and anæmia.

Diagnosis should be made between those and enlargements due to Hodgkin's disease, or splenic anæmia, and other general diseases which are not benefited by excision.

Treatment.—When operation is called for the spleen should be excised.

Movable spleen may be determined by indefinite digestive troubles, dragging pains and vomiting; absence of splenic dulness, and presence of a movable tumour in the abdominal cavity or the iliac fossa. If the pedicle becomes twisted, strangulation is apt to follow, and lead to signs of peritoneal irritation.

Treatment.—When operation is required, the spleen is exposed, and if normal, fixed to the abdominal wall (**splenopexy**). As sutures in its substance are apt to cause profuse bleeding and also to cut through, the spleen should be inserted into a pocket of parietal peritoneum, or even between the muscular planes, and surrounded by sutures to prevent it from slipping. (*Rydygier's method*).

CHAPTER VII.

RECTUM AND ANUS.

Imperforate anus (*atresia ani*) is a congenital defect due to non-perforation of the cloaca and the skin, as obtains in normal development. There are three principal varieties—(1) where the rectum, as a blind pouch, reaches to just beneath the skin covering the anal region, which alone separates it from the surface; (2) where it stops at variable distances in the pelvis, and is separated from the anal surface by a considerable depth of tissue; and (3) where it opens into the bladder or urethra (or the vagina), forming a true cloaca.

Treatment.—When the rectum is separated from the surface by only a thin membrane, a puncture should be made, and the opening dilated. If it is obviously separated by a considerable thickness of tissue, a colostomy should be performed; and when the child is older and the parts larger, a plastic operation to bring the rectum down to the perineum can sometimes be carried out. In the cloacal form, the alimentary and urinary canals can sometimes be separated in a similar way.

Wounds and **injuries** are not common, except in women during parturition; but they may occur from the presence of substances swallowed; or from foreign bodies introduced either intentionally, or accidentally by sitting down suddenly on them, etc.

Pruritus ani is annoying itching, coming on especially when the patient is warm in bed. It is induced by general constitutional conditions like gout, disorders of digestion, and by certain articles of food, etc., and is aggravated by constipation and eczema; in children it is often caused by thread worms.

Treatment.—The general health should be attended to: the parts must be washed after each motion, and bathed twice daily with lead or silver nitrate lotions. If the itching still persists, incisions may be made around the anus; or a few drops of weak carbolic solution injected beneath the surface. In obstinate cases, the whole skin area affected may require to be excised.

Fissure of the anus is a painful crack at the junction of the skin and mucous membrane. It is caused by the passage of hard fæces, and often accompanies piles, and other diseases. It is kept from healing by the spasms of the sphincter which it induces. There is sometimes a small ("*sentinel*") pile at the distal end of it; and this is said to be the result of an anal valve (of Morgagni) being torn down, (Ball).

The **symptoms** are intense pain on defæcation; and this often deters patients from emptying the bowels regularly, thus encouraging further constipation. In severe cases any movement, such as walking or coughing, excites the pain. On stretching the skin of the anus the ulcer is at once seen.

Treatment.—If the fissure does not heal with the use of laxatives and astringent lotions, the patient is anæsthetised, and the anus is stretched with the thumbs until the sphincter yields, and the fissure tears asunder. This paralyses the muscle (for five to ten days), by which time the ulcer is usually healed. Larger fissures should be excised by a V-shaped incision.

Proctitis (*inflammation of the rectum*) arises sometimes in the course of dysentery, and occasionally by gonorrhœal infection, or from other sources of irritation.

The **symptoms** are great tenesmus, with frequent passage of fæces, and later of bloody mucus alone. There is usually œdema of the mucous membrane, and often some prolapse; a feeling of heat and weight in the pelvis; and sometimes vesical irritation. If it becomes chronic, the mucous membrane becomes indurated, and ulcers may appear on the surface, while the discharge is generally muco-purulent.

Treatment.—The bowels are first emptied by means of a series of saline purges. Rest in bed, hot sitz-baths, and suppositories of morphine and atropine afford relief to the congestion and discomfort. The food must be wholly digestible and bland. In the chronic form astringent lotions should be used.

Periproctitis (*inflammation of the tissues around the rectum*) arises from injuries due to fish-bones, etc., swallowed, but more frequently as a result of infection passing through the mucous membrane; it may follow diseases of the rectum, such as ulcers, cancer, inflamed piles, etc. It may arise also from suppuration outside the rectum, as in the ischio-rectal fossa, the pelvic bones, prostate, or even in Douglas's pouch. *Diffuse inflammation* is always grave, and may spread in any direction : it is apt to invade the abdominal cavity, and cause death.

Circumscribed inflammation generally proceeds to the formation of abscesses, giving rise on bursting to *sinuses*, which are known as "*fistulæ in ano.*" *Superficial* abscesses present (1) beneath the skin at the margin of the anus, and on bursting leave a "*blind external fistula*"; (2) beneath the mucous membrane above the anus, where they may burst through ("*blind internal*"), or penetrate the rectal muscle and present in the ischio-rectal fossa, where the opening again forms a "*blind external fistula*," or if the abscess has burst also at the mucous surface a "*complete fistula*" (true fistula).

Deep abscesses arise in (3) the ischio-rectal fossa, (**ischio-rectal abscess**), whence they are apt to burrow widely round the rectum and penetrate the mucous membrane (forming *internal*, or if open at both ends, *complete fistulas*) ; or spread into the retroperitoneal tissue, where they may burst, and cause fatal peritonitis. *Ischio-rectal abscesses* are occasionally acute, and are accompanied by fever, etc. ; but the chronic forms are more common. They are sometimes tubercular in origin, but as a rule ultimately become infected with pyogenic organisms. There is fulness and tenderness of the affected side, and the skin is often reddened or dusky in the later stages. (4) Abscesses arise also in the *pelvi-rectal* space, (*i.e.*, the space surrounding the rectum above the levator ani), from infection spreading from the mucous membrane, or from the prostate. The abscess is difficult to detect ; but it pushes the mucous membrane forward into the lumen, and may then burst through, forming a "*blind internal fistula.*"

Treatment.—Abscesses must be opened and drained as soon as diagnosed ; those presenting superficially on the mucous membrane alone may be opened from the inside : but external abscesses and those communicating with the ischio-rectal fossa always by an external incision. If an abscess starts from the prostate, a transverse cut should be made down to it in front of the anus.

Fistula in Ano.—The **symptoms** are pain and discomfort in the parts during defæcation, and even on movement ; discharge of muco-purulent fluid ; and occasionally inflammation of the fistula, giving rise to increased pain and discharge. There is usually depression of spirits, and general ill-health.

Treatment of fistula in ano is division of the tissues between the skin and the anal canal, so that the fistulous passage is converted into an open channel, which is allowed to granulate from the bottom. Internal sinuses should be converted into complete fistulas, by inserting a curved director into the small opening in the mucous membrane, and cutting on it outwards. In all cases the lining wall, especially when of long standing, should be cut or curetted away; and in external fistulas, it is usually sufficient to open up the sinus and remove the lining, after which it may be closed with a few sutures; though complex sinuses must be laid completely open. and packed with iodoform gauze.

After-treatment.—The patient is kept on fluid diet for three days or so, to prevent movements of the bowels: opium should not be used for this purpose, though a little may be given at first for the pain. The wound should be washed with warm lysol solution after each defæcation, and covered with a light dressing. The patient should be confined to bed for a week or ten days, but allowed to go about after that.

Hæmorrhoids or **piles** are swellings caused by dilatation and varicosity of the hæmorrhoidal veins; they are extremely common complaints. External piles originate from the inferior, and internal piles from the superior hæmorrhoidal plexus; the chief seats being where those two sets of veins meet, and the two forms being frequently combined.

Pathology.—The veins in this part lie between the mucous membrane and the muscle, and have therefore but slight support: they are in communication with both the systemic and portal veins, and are influenced by congestions of either; they possess no valves, and have thus to bear the weight of the whole column of blood from the liver downwards. Dilatation is common amongst persons of sedentary habits; and is provoked by anything which causes congestion of the parts: and piles are specially apt to arise, if the veins have been subject to previous inflammation. There is some reason, however, for belief in their congenital origin as cavernous angeiomata, which do not develop until some change in the vascular pressure takes place.

Symptoms.—*External hæmorrhoids* may produce no symptoms, unless attacked with thrombo-phlebitis. They appear after defæcation as bluish masses beneath the skin around the anus, singly or in clusters, varying from the size of a pea to that of a filbert; and reducible on steady pressure. When they are inflamed, the blood coagulates, and they become exceedingly tender and painful; the surface is distended and angry-looking; and painful fissures are apt to develop between the masses. When the attack subsides, the tissues remain thickened, and although the blood is absorbed, there still remains a more or less permanent sac, into which the blood tends to gravitate. The attacks recur from time to time, and may eventually disable the patient by reason of pain and general distress. *Internal hæmorrhoids* (usually accompanied by external) form sessile masses within the sphincter, attaining sometimes to the size of a walnut. They cause indefinite pain and weight in the pelvis, and discomfort on defæcation; and there is usually considerable hæmorrhage, which, owing to the great tension, may have the appearance of arterial bleeding. They become easily prolapsed; and in cases of long standing, become so thickened and enlarged, from repeated thrombophlebitis, that they are no longer reducible, and are often the seat of superficial ulcers. There is generally some rectal catarrh, causing a discharge of mucus. As there is a possibility of malignant disease being the real origin of such symptoms, the rectum should always be examined with the finger, an anæsthetic being used if the pain is extreme. A proctoscope (or rectal speculum) is a valuable aid for determining the conditions present.

Treatment.—Habitual constipation must be warded off by the use of unirritating laxatives (cascara, saline waters, etc.); congestion, by avoiding alcohol, spices, etc., and habits which induce it; and irritation, by cleansing the parts with soap and water after each motion, and by wearing soft underclothing. The pain of inflamed piles may be subdued by rest, application of gall and opium ointment or lead lotions, or, in extreme cases, of ice-bags or poultices. Incisions in the thrombosed piles usually give some relief.

Operation.—The great majority of cases require no surgical treatment; but operation for radical cure is indicated (1) for recurring hæmorrhages; (2) frequency of prolapse, with difficulty of reposition; (3) repeated attacks of inflammation, and (4) persistent ulceration. The patient is anæsthetised, and placed in the lithotomy position, or laid on his side with the legs drawn up. The anus is well dilated, when the piles roll out with the everted mucous membrane. They may be cut off, after secure ligation, or crushing with a powerful clamp (*Allingham's*); or removed simply with clamp and thermo-cautery at a dull red heat. If possible they should be excised, and the wound sutured; if isolated, they may be caught in a long forceps which clamps the base until the stitch can be inserted. If they are in masses, a complete resection of the pile-bearing area of mucous membrane should be made (*Whitehead's operation*), and the cut ends sewed together. As there is usually much bleeding, the operation should be done piecemeal; or special clamps (*Coates's*) may be used to enable the sutures to be inserted before the piles are cut. The skin should not be encroached upon, or troublesome stenosis may follow. Piles may be obliterated sometimes by injection of one or two drops of glycerine of carbolic acid into them, to set up inflammation which afterwards leads to atrophy.

After-treatment.—The bowels should be kept from acting for several days, by restricting the food to a minimum; opium should not be used, except after Whitehead's operation, in which healing by first intention may be hoped for. The pain of the first motion may be mitigated by injection of oil to soften the fæces and lubricate the canal.

If **stenosis of the anus** results from operation or disease, the opening must be treated first by gradual dilatation; and if this fails, a plastic operation may be made to restore a border of flexible and distensible skin.

Prolapse of the rectum (*procidentia recti*) is protrusion of the rectum out of the anus. The mucous membrane alone, or the entire rectal wall (*complete prolapse*), may be protruded; and in the latter form a loop of bowel may descend between the layers (*prolapse-hernia*). In other cases the upper part of the rectum may be invaginated (*intussuscepted*), and the intussusceptum extruded. It is induced by relaxation of the submucous tissue and the sphincters, and by continued or spasmodic expulsive efforts, associated with irritation of the bowels or difficulty of micturition arising from any causes. The slighter forms sometimes follow from repeated extrusion of hæmorrhoids.

Signs.—The prolapse appears as a ring or a cylinder of mucous membrane, or in extreme cases of a large globular mass outside the anus. The surface is at first red and moist:

but after frequent protrusion, it becomes congested and indurated, and may discharge muco-purulent secretion; and with long exposure is apt to become dry and leathery, and occasionally ulcerated. It may become so thickened as to be irreducible; and in some cases it undergoes strangulation.

Treatment.—The prolapse should be reduced by steady squeezing after lubrication of the surfaces, with the finger inserted in the orifice. When reduced, the bowel must be kept from returning by a pad and figure-of-8 bandage across the perineum: obturators for insertion in the anus should be avoided. In children the buttocks should be strapped together with adhesive plaster in such a way that the fæces can pass between them: and if the predisposing cause of straining is removed, and the motions kept soft with laxatives, this is usually sufficient to effect a cure. In adults the prolapse often recurs, but it should be replaced each time; and for prevention, the patient may defæcate into a bed-pan while lying on his side. In the mucous variety astringent applications are of use; and in obstinate cases strips of the redundant mucous membrane may be removed by excision and suture, or by cautery, in either case in the longitudinal direction of the bowel. When the perineal tissues are very lax, injections of paraffin have been made around the anus, with some success in narrowing the opening. In complete prolapse, recurring in spite of reposition or the application of supports, the abdomen may be opened, and the rectum or sigmoid may be drawn up and fixed in the abdominal wall (**proctopexy**). In irreducible cases the prolapsed portion should be resected close to the anus, the two layers in contact being sewed together with through and through stitches; care being taken to avoid damaging any herniated loop of bowel in the prolapse.

Tumours of the anus are rare, but *condylomata* are common in this situation. *Epithelioma* may arise in the anus; but *carcinoma* is more commonly secondary to that of the rectum.

Tumours of the Rectum.—The commonest benign tumours are **polypi**, arising chiefly from the posterior surface at the lower third. They should be removed, with ligation of the pedicle, after dilatation of the sphincter; or if far up, with the aid of a proctoscope and long forceps.

Papillomas resemble both polypi and cancers; they occur as small cauliflower masses, but are usually pedunculated, and present no indurated bases. After removal, they should be examined microscopically in order to make sure of their innocuous nature.

Sarcoma is occasionally met with: it forms a soft nodular mass, and the epithelial covering does not become eroded until the tumour breaks through. It is treated like carcinoma.

Cancer of the rectum occurs usually in persons of advanced age, but may commence as early as the twenty-fifth year. It is generally *tubular* (*cylinder-celled*) *carcinoma*; and may be hard or soft. It begins as a small flat induration, without forming a tumour for some time; the surface epithelium becomes eroded, and leaves a bleeding and hardened base. The edges proliferate, and ultimately become circular cauliflower masses forming an everted edge round a central indurated ulcer. The tumour extends chiefly in the submucous tissue, to which it is confined for a considerable time before penetrating the muscular layer. The lymphatic vessels and glands, following more or less the line of the hæmorrhoidal veins, become involved at the same time; but this occurs much earlier with the soft and gelatinous cancers. Clinically they are met with (1) in the ampulla, just above the anus (the commonest situation), forming isolated round tumours, and extending gradually till the whole circumference is involved: (2) high up in the rectum (2 or 3 inches above the anus), and forming ring-shaped masses of the scirrhus type, and soon giving rise to stenosis: a less common form occurs (3) as a soft tumour which soon infiltrates the muscular layer and lymphatics, and spreads as a cylindrical growth up and down: it is usually situated at the lower part of the rectum, and is met with generally in younger patients.

The **symptoms** are often late in appearing, in fact not until the disease is well advanced. At first there is uneasiness or even tenesmus on defæcation. This is followed by the passage of blood and mucus (one of the earliest reliable signs); and later by stenosis. The fæces may be streaked with blood, and ribbon-shaped, though the latter condition is not constant, nor characteristic of cancer. When stenosis becomes more advanced, the fæces may accumulate in the rectum, especially if constipation is not prevented; and the discharge may collect as an offensive fluid above the stricture, and come away in sudden gushes on straining at stool. Particles of ulcerated mucous membrane may be voided, and extreme destruction of the tissues usually relieves the stenosis for a time. Pain is often absent until the disease penetrates to the surrounding structures, when it may become almost unbearable. Good health is often maintained until ulceration and stenosis induce septic absorption; after which weight decreases, and anæmia comes on, usually accompanied by a yellowness of the skin. Infiltration of the rectal muscle is apt to cause incontinence; and, further, it may set up ulceration and perforation into the bladder, (or vagina), and thus lead to cystitis, with evacuation of fæcal discharge in the urine, and urine in the motions.

Diagnosis.—Cancer is apt to be overlooked altogether if digital examination is omitted in cases of rectal trouble of any sort. It may also be mistaken for bleeding piles, or for simple constipation, or diarrhœa. The rectum, therefore, should always be examined with the finger, to determine the situation and limits of the tumour, and the extent of the ulceration and induration. A clear view can usually be got with the proctoscope, and the conditions and limits much more accurately gauged.

Treatment is either radical, (extirpation of the tumour and its surrounding tissues); or palliative, (relief of obstruction, diminution of toxic absorption, and mitigation of pain).

Radical treatment is indicated when the tumour is small and isolated, and can be easily reached; especially when it is freely movable, or even lightly adherent to unimportant structures. It should *not* be attempted when infiltration has spread to the sacrum, bladder, or uterus, or to other parts of the bowel; or if metastatic growths have taken place in the liver, retro-peritoneal glands or elsewhere. In doubtful cases an exploratory laparotomy should be performed; and if the extirpation is impossible, the incision may be utilised for an artificial anus. Cancers low down in the rectum are, as a rule, more favourable for extirpation through the perineum; but a cancer high up may be removed by the abdominal route. Before any operation, the bowels should be cleared out, with doses of castor oil and enemata, repeated for several days, until they are thoroughly emptied; the patient being fed meanwhile on wholly absorbable food.

Operations.—Cancer in the lower part may be removed through the dilated anus, by a circular incision (*perineal resection*); the rectum (including the muscular wall) being cut across above the external sphincter of the anus, separated round the outside, drawn out of the anus, and divided at least an inch above the tumour. The two ends may be sutured together if the rectum is sufficiently mobilised. In women, part of the vagina may be removed if necessary or more convenient. Should the tumour be situated more than an inch or two up, it cannot be well reached through the perineum alone; and the tissues alongside the sacrum (*parasacral*) may be divided. *Sacral Operations.*—In order to gain more room, the part of the sacrum on the left side below the level of the 3rd sacral foramen may be resected (*Kraske*). The nerves issuing below this part (the 4th and 5th sacral) supply the muscles of the bladder and rectum; but their destruction does not apparently interfere with the function of those organs; and as the sacral canal is not usually opened, the operation therefore does not lead to spinal meningitis. The soft tissues are dissected off the sacrum and coccyx, and the latter bone is removed entirely; the piece of the sacrum is cut away with chisel and gouge-forceps; the rectum dissected off (bluntly with the fingers) from the sacrum behind, and the soft tissues in front. If the tumour is high up, the peritoneum must be opened, and the upper part of the rectum loosened and drawn down. When mobilised and drawn out into the wound, it is packed round with gauze, cut across above and below the growth, and the ends joined. If the tumour is too extensive to allow of this junction, the upper end may be implanted into the sacral wound; or the end may be closed, and an artificial anus made in the inguinal region. The wound is partly sewed and partly packed with iodoform gauze for four or five days; and in any case drainage must be maintained for some time, as the posterior part of the junction rarely heals by first intention, though the fistula generally closes ultimately. Many modifications have been made in the method of bone resection:—the 4th and 5th nerves of both sides, and even the 3rd of one side, have been removed without causing serious inconvenience (*Bardenheuer, etc.*). Attempts have also been made, but without great success, to make use of osteoplastic flaps, with replacement of the bone. The *abdominal operation* consists in exposing the rectum by an abdominal incision, cutting it across under clamps well above the disease; dissecting off the lower part, along with any enlarged glands, and removing it, (sometimes by invaginating it through the anus); and fixing the end of the upper part in the abdominal wound to make an artificial anus.

Palliative treatment consists chiefly in making an artificial anus in the inguinal region, and thus relieving tenesmus and pain caused by the passage of fæces over the tender surfaces. For the same purpose, resection of the rectum may be performed purely as a palliative measure, even when elimination of the whole disease is out of the question. The results of artificial anus in this disease are on the whole very satisfactory. The patients, with proper regulation of the bowels, gain a considerable amount of control over the motions in time, and they are greatly relieved from the distressing symptoms. The lower part of the bowel may be washed out from above or below, to prevent foul discharge from accumulating and becoming absorbed.

Stenosis or **stricture of the rectum**, besides arising from the presence of malignant tumours, may be caused by cicatricial narrowing after ulceration (from dysentery, and especially syphilis), or injury; by inflammation outside the rectum (*pelvic*, or *parametritic*); or by pressure of tumours or cysts in the pelvis. In the cicatricial variety (the most common), the lumen is narrowed by a fibrous ring; the bowel is dilated above with fæces; and the muscular wall hypertrophied by efforts to overcome the obstruction. Secondary ulcers or fistulæ are not uncommon.

The **symptoms** are obstinate constipation; with occasional attacks of diarrhœa, due to catarrh from retention of fæces. In extreme cases, obstructive ileus may be developed.

Diagnosis is made by inspection, with the aid of a rectal speculum, and by rectal bougies.

Treatment consists of dilatation with graduated bougies, carried out slowly and gently, if necessary with the aid of anæsthesia. If this is not successful, *linear incision* may be made down towards the sacrum and coccyx from the lumen with a probe-pointed knife. In obstinate cases the stricture should be excised completely; or if this is impossible, an artificial anus may be made.

CHAPTER VIII.

URINARY ORGANS.

KIDNEY AND URETER.

Examination of the Kidney.—For palpation, the body should be lying flat, or on the side, with the knees drawn up towards the chest; the front and back of the lumbar region are pressed together between the hands (*bimanual palpation*). The kidney in ordinary circumstances cannot usually be felt, unless the abdominal tissues are very thin and the muscles deeply relaxed: any kidney therefore that can be easily felt, is generally misplaced or enlarged. Deep pressure on a normal kidney sometimes gives rise to a sinking or sickening feeling, and if a stone is present occasionally to pain. Percussion is useful in swellings, for mapping out the relations with the colon. X-rays sometimes show the presence of a stone or even of tumours. The urine by its quantity and quality, and the presence of abnormalities, gives most important information.

The efficiency of a kidney is determined by the secretion of (*a*) water, (*b*) solids (urea, salts, etc.), and (*c*) by the absence of pathological substances. The urine may be collected from each kidney by catheterisation of the ureters (a difficult undertaking, except in women); or by means of one of the various "segregators." The ureteral openings may be observed by the cystoscope; and much information can be derived from the appearance of the discharge from them.

Renal pain may arise from (*a*) obstruction to the exit of urine from the kidney; (*b*) from foreign bodies, tumours, or inflammation of the pelvis of the kidney; (*c*) sudden increase in tension, from congestion and swelling; (*d*) traction on the nerves, by displacements or pressure. The parenchyma of the kidney is said to be quite insensitive; but irritation of the pelvis or ureter gives rise to discomfort, pain, or spasm. Paroxysmal pain is generally due to obstruction, or to certain poisons; persistent dull pain to inflammation, tumours, or tuberculosis; while a sharp pain, with external tenderness, and especially with œdema or fluctuation, usually indicates a perinephritic abscess.

Anuria.—The urine may be suppressed altogether by (*a*) mechanical means (obstructive suppression), from impaction of a calculus, or kinking or constriction of the ureter; or (*b*) by the effects of general diseases, or poisoning; (*c*) by renal diseases; or (*d*) reflex spasm of both kidneys, or of one only when the other is obstructed or absent.

Hæmaturia may originate in the *kidney*, by (*a*) injury, or irritation of a calculus; (*b*) inflammation (nephritis, pyelitis): (*c*) passive hyperæmia, from pressure or torsion of the pedicle: (*d*) or tuberculosis, tumours, or cystic degeneration; or in the *ureter*, from disease or injury. The blood is intimately mixed with the urine, and is of the same dilution at all stages of micturition. Blood may also come from the *bladder* or *prostate*, in which case it appears mainly at the end of micturition, is less intimately mixed with the urine, and is often in clots. If it comes from the *urethra*, it appears at the beginning of micturition, the urine passed later being clear. Hæmaturia may be distinguished from *hæmoglobinuria*, by the presence of corpuscles; and from *carboluria* (from absorption of carbolic acid), by the characteristic spectrum.

Pyuria.—When pus comes from the kidney, the urine is generally acid; when from the bladder, it is often alkaline, foul smelling, and mixed with mucus, and often contains large flat epithelial cells from the bladder wall. Pus originating in the prostate may be squeezed out into the bladder by pressure through the rectum; and pus from the uretha is washed away with the first drops of urine.

Albuminuria is due to (*a*) acute or chronic nephritis: (*b*) pus or blood in the urine: or, apart from suppuration, to the results of (*c*) injury; (*d*) movable kidney, and hydronephrosis; (*e*) tuberculosis and syphilis; and (*f*) tumours and cysts.

Abnormalities.—One kidney may be absent, or rudimentary. The two kidneys may be fused into one, producing (*a*) a single large kidney on one side, or (*b*) a *horse-shoe* kidney, or even a flat disk, extending across the vertebral column. The pelves or ureters may be doubled in all or part of their extent.

Displacements.—**Congenitally**, a kidney may be misplaced from its normal situation,—up, down, or to either side: or its axis may be altered in any direction.

Movable Kidney.—All kidneys, unless fixed by inflammatory adhesions, are more or less movable; but excessive amount of movement occurs commonly in women.

The **ætiology** is still uncertain; but it is met with chiefly in those with long, narrow waists; it is far more common on the right side; it is often associated with emaciation after previous obesity; and occasionally follows repeated pregnancies and tight lacing. The mobility varies from a slight exaggeration of the normal movements, to wide displacements into the pelvis or to the opposite side. These take place in the lax subperitoneal tissue: a mesonephron (allowing of the production of a true "*floating kidney*") being most uncommon.

Symptoms.—As a rule, it causes no inconvenience, and often is only discovered accidentally. In some cases, however, there is a sense of dragging and weight, associated with general signs of indigestion and depression of spirits; sometimes there are spasms of pain accompanied by collapse and vomiting, and extreme sensitiveness of the kidney. These attacks are nearly always associated with kinking of the pedicle, which produces congestion from obstruction of the veins, and retention of urine in the kidney from obstruction of the ureter. They generally pass off in an hour or two, but may last for a couple of days or more; and the termination is often marked by a great flow of urine. A movable kidney can generally be felt on deep palpation gliding under the fingers like a piece of slippery soap; and it is often more easily detected when the patient is standing up.

Treatment.—The kidney should be replaced; and if possible any kink in the pedicle reduced by manipulation. As long as the patient is kept recumbent, there is little tendency to recurrence. It may sometimes be fixed by means of a soft pad attached to the stays so as to rest under the lower border of the organ: a pnuematic pad being the most convenient, as it adapts itself to the movements of the thorax and abdomen, without giving pain from pressure on the ribs. In many cases, however, pads are of no use; and if the patient is disabled by the mobility, the kidney must be fixed to the posterior abdominal wall (**nephropexy—nephrorraphy**). An incision is made in the lumbar region outside the edge of the quadratus lumborum, downwards and outwards, from the 12th rib; the muscles are separated; the fatty capsule is opened, the kidney is caught, and pulled into the wound. The true capsule is incised along the convexity, and part of it stripped back; two or three stout chromic gut sutures are inserted deeply in the cortex and the reflected capsule, and penetrate the muscles on each side of the wound, where they are tied together, so as to close the wound and fix the kidney. Strips of gauze should be packed down to the kidney, for drainage, and also to encourage the formation of adhesions. The operation is carried out with the patient laid face downwards, the belly resting on a narrow air pillow (*Edebohl's*) to push the kidney up into its place.

Hydronephrosis (or **uronephrosis**) is dilatation of the calices or pelvis of the kidney, usually accompanied by dilatation of the ureter.

Cause.—(*a*) *Congenital*: the ureter may end blindly, or may be strictured or kinked; and the child may be born with hydronephrosis. (*b*) *Acquired*: passage of urine may be obstructed, by calculi or blood clots (or even parasites) in the calices, pelvis, or ureter; by inflammatory swelling or œdema, constriction or kinking of the ureter; valve-formation at the junction of pelvis and ureter, from displacements or pressure; external compression by tumours, cysts, or displaced organs (*e.g.* uterus); constrictions following abdominal inflammations; or inflammatory thickening or tumours of the bladder wall, obstructing the ureteral meatus. Obstruction to the outflow from the bladder (due to enlarged prostate, stricture of the urethra, or phimosis) seldom causes hydronephrosis till a late stage.

Pathology.—Sudden obstruction tends to stop the secretion of fluid as the back pressure approaches that of the renal vessels; but there is a certain amount of distension, and, in some cases, a real hydronephrosis may be formed. As a rule, however, dilatation arises from incomplete, intermittent, or gradually increasing obstruction. The pelvis and calices become distended, and the cortex atrophied from pressure, until the whole kidney may be converted into a large irregular cyst. The further the atrophy advances, the more watery becomes the secretion until urea and other solids entirely disappear. At any time a hydronephrosis may become infected, and lead to *pyonephrosis.*

Symptoms.—Sudden attacks cause pain from distension of the sensitive pelvis. Gradual onset gives little evidence but the development of a swelling, which may cause pressure symptoms on the adjoining organs, especially the stomach. It is fluctuant, and dull to percussion, but covered partly with resonant colon. The urine from the same side is stopped or diminished ; and in the intermittent forms (due to displacements, or to ball-valve action of a calculus) great discharge of urine may occur at intervals, accompanied by diminution of the swelling.

Diagnosis from pyonephrosis, hydatid cysts of kidney or liver, distended gall-bladder, pancreatic cysts, ovarian cysts, distended urinary bladder, and (when there is great tension) from tumours of various kinds.

Treatment.—Any external cause, such as strictures or enlarged prostate, must be treated ; otherwise the kidney should be exposed by a lumbar incision and opened (*nephrotomy*), and drained ; any evident internal cause should be dealt with (calculus, stricture of the ureter, etc.). If obstruction cannot be removed, and the constant discharge from the sinus gives rise to irritation, the kidney may have to be excised (**nephrectomy**).

Inflammation of the kidney (**nephritis**) may arise in surgical conditions. In the *interstitial* form (originating sometimes from back-pressure of the urine), there are vague symptoms of illness, with wasting and anæmia ; the urine being passed in large quantities, and containing little albumen. For fuller details and treatment, see a work on medicine.

Pyelitis (inflammation of the pelvis of the kidney) generally arises from infection spreading from the ureter, bladder, prostate, or urethra, especially when the outflow of urine is obstructed. Urine retained anywhere is apt to undergo decomposition, and cause inflammation in the tissues with which it is in contact : hence the disease often involves the substance as well as the pelvis of the kidney (*pyelo-nephritis*). Infection may arrive through the blood stream, since the kidney is one of the chief channels of excretion of microbes from the blood. In this way a collection of urine, or simple inflammation of the pelvis, caused by a calculus or other foreign body (bullets, parasites, etc.) may become purulent.

It arises also by secondary infection in the course of tubercular disease.

Symptoms.—In simple pyelitis there is frequency of micturition; pain or uneasiness in the lumbar region, increased by pressure, but not by movements; and pyuria. The urine is acid, and contains little albumen (only enough to be accounted for by the pus), and occasionally a trace of blood. The pus often disappears intermittently, owing to temporary occlusion of the ureter; and at these times there is usually some pyrexia.

Treatment.—The patient must be kept warm, and restricted to fluid diet; and alkaline waters should be given freely. Acute exacerbations may be relieved by hot fomentations, or by morphine if necessary. Decomposition of urine may be checked by internal administration of urotropine and quinine, and if there is cystitis, by daily irrigation with boracic lotion. Calculi or foreign bodies should be removed from the pelvis; and even if they are not discovered, the kidney should be drained for a time.

Pyelo-nephritis is inflammation of the parenchyma as well as of the pelvis of the kidney. It is apt to arise in the course of long-continued disease of the lower urinary organs, especially when associated with retention of urine. It is often provoked by some slight surgical irritation (catheterisation, etc.), hence the old name of "*surgical kidney*." Apparently in these cases a reflex congestion is set up, ultimately becoming an established inflammation; or perhaps it is due to sudden toxic absorption from the injured mucous membrane.

Symptoms.—It begins with a rigor and rise of temperature: and general inflammatory signs of an asthenic type appear, dry tongue, vomiting, diarrhœa, and emaciation. The urine varies in quantity, but as a rule it is diminished. The disease usually progresses until the patient dies of uræmia or exhaustion.

Treatment is usually confined to general maintenance of strength; and the administration of urotropine and benzoate of soda, and copious draughts of fluids, to render the urine acid and antiseptic and flush out the kidneys. If an abscess develops it should be opened; and even without it the kidney may be incised with the object of preventing septic absorption.

Abscesses in the kidney may follow any condition of infection, and are most frequently of the pyæmic type. Occasionally a circumscribed abscess forms, and grows until a fluctuating mass can be distinguished. If possible, it should be treated by drainage; if that is not sufficient, the kidney must be excised.

Pyonephrosis (distension of the kidney and pelvis with pus) arises from (*a*) retention of pus in a case of pyelitis, and (*b*) suppuration occurring in a hydronephrosis.

The **symptoms** are essentially those of hydronephrosis, with pain, fever, etc., from the suppurative inflammation; and, if the obstruction is incomplete, pus in the urine. This condition is generally associated with a certain amount of nephritis, and also of perinephritis.

Treatment.—In most cases *nephrectomy* is required, as simple incision and drainage generally result in the formation of a persistent *fistula*, which may lead to amyloid disease in the other organs.

Perinephritis, with abscess formation in the loose tissues surrounding the kidney, may arise from suppuration of the kidney or ureter; inflammation spreading from the bowels or the pleura; or disease of the ribs or vertebræ. It may point externally, either posteriorly outside the erector spinæ, or anteriorly in the groin (resembling a psoas abscess); or it may discharge into the peritoneal or pleural cavities, or into the intestine.

Symptoms.—In the acute form there is pain in the loin, tenderness on pressure, and sometimes œdema; rigors, fever, etc. The chronic form generally gives no indication of its presence until a large abscess has formed.

Treatment is incision and drainage. If tubercular in origin, it is treated like tubercular cavities elsewhere.

Urinary calculi are composed of uric acid or oxalate of lime, secreted from the kidney in a crystalline form, and cemented together by mucus or blood. When surrounded by decomposing urine, as they frequently are, if retained long in the kidney or bladder, they become coated with phosphates. *Uric acid* calculi are rounded and smooth, light brown in colour, and firm, but rather brittle; *oxalate* are rough and knobby (resembling *mulberries*), dark brown or almost black in colour, and very hard; *phosphates* are large and smooth, pure or dirty white in colour, and soft or friable in consistence, and generally formed around a nucleus composed of one of the other kinds of calculi, or of a foreign body (blood clot, stitch, etc.). Sometimes a calculus is formed of alternate layers of different materials (*laminated*).

Renal calculi may be small grains, or large branched masses filling out the pelvis and penetrating the calices. When small, they pass down the ureter as sand or gravel into the bladder, where they may form larger calculi by accretion, or may be voided. A small stone, large enough to distend the ureter, gives rise, in passing down, to extreme pain and collapse (*renal colic*), which persists until the stone is expelled into the bladder, or falls back into the pelvis of the kidney. If too large to escape from the kidney it sets up inflammation (*calculus nephritis*, *pyelitis*, or *pyelonephritis*) ; and if it becomes impacted at the exit, it causes *hydronephrosis* ; and, if suppuration takes place, *pyonephrosis*. Or it may set up complete obstruction to the passage of urine ; and if the other kidney is blocked from any cause, entire suppression (*calculus anuria*). Secretion occasionally stops suddenly in the other kidney also, even when apparently sound, by reflex action (*reno-renal reflex anuria*), after operation on the diseased kidney, or indeed after any irritation of the urinary system.

Symptoms.—If the stone is smooth, and fills the cavity without leaving much room for movement, there are often no symptoms, but occasionally those of slight interstitial sclerosis. If there is irritation, it gives rise to frequency of micturition : pain in the lumbar region, groin, loin, testis, or even (in rare cases) entirely in the opposite sound kidney (*reno-renal reflex pain*) ; retraction of the testis ; blood or pus in the urine. Violent exercise or jolting increase all those symptoms. The urine, even when purulent, is usually acid ; it should be collected from the one kidney by means of a segregator, or if possible by catheterisation of the ureter. On cystoscopic examination, pus or blood may be seen issuing from the ureteral meatus. Deep palpation of the kidney sometimes gives rise to a sharp pain ; but this is an inconstant sign. Stones are sometimes revealed by X-rays ; uric acid stones have only the density of flesh, and generally escape notice ; phosphatic have, as a rule, the density of young bone, and are often seen in a skiagram ; while oxalate give a deep shadow, and are generally plainly visible. Renal colic, hydronephrosis, or calculus anuria may come on at any time.

Diagnosis.—From hæmaturia of other origin, it is distinguished by the absence of disease of the bladder, prostate or urethra ; and by confirmatory signs of calculus. From tuberculosis of the kidney, by the increase of pain on movement, the more common occurrence of hæmaturia, the passing of gravel, and occasionally by X-ray examination.

Renal colic, already mentioned, comes on suddenly; and occurs in spasms of excruciating pain, which is referred to the kidney, or to the branches of the genito-crural nerve. It is accompanied by collapse, cold sweats, nausea, and vomiting; retraction of the testis, frequency of micturition with straining to empty the bladder (*strangury*), and often blood and urates in the urine; occasionally there are cramps in the bowels, and tenesmus. The temperature is generally subnormal, and the pulse is weak and rapid. The attack passes off as suddenly as it begins.

It is *diagnosed* from *biliary colic*, by the absence of jaundice. and the localisation of the pain at a lower level; from *spasms of the bladder* of other origin, by the absence of disease or distension of the bladder; from *peritonitis*, *acute appendicitis*, and *intestinal obstruction*, by the absence of rigidity of the abdominal walls, distension of the bowels, or stercoraceous vomiting; from severe *lumbago*, by the reference of the pain to the urinary organs, and the absence of exacerbations on muscular movements; from *metallic poisoning*, by the absence of diarrhœa, or griping of the bowels; in women, from *dysmenorrhœa*, by the want of relationship of the attacks to the menstrual periods.

Treatment.—*Renal colic* should be treated by hot fomentations, and morphine when necessary. Surgical treatment of *calculus* is extraction by **nephrotomy** (*nephro-lithotomy*). The kidney is exposed (as for movable kidney) and drawn into the wound; here it is incised down to the pelvis along the convexity (rather towards the back), where the vessels become terminal, and where bleeding is reduced to a minimum. The pelvis is explored with the finger, and the ureter with a large smooth bougie. When the stone is removed, the wound is closed; but drainage is continued until discharge of urine ceases. Even if no stone is found, the symptoms often subside. Occasionally blood clot collects in the bladder; it should be broken up with a sound or lithotrite, and washed out; in some cases it may be necessary to open the bladder for this purpose. If a stone is discovered in the *ureter*, it may be extracted by extending the incision downwards towards the iliac spine: or if very low down, by means of an abdominal incision; while if impacted in the ureteral meatus, it should be extracted through the bladder by means of a suprapubic cystotomy.

Tuberculosis generally begins in the kidney as tubercular pyelitis, or as isolated nodules confined at first to the pyramids: when these break down and discharge into the ureter, the rest of the organ becomes infected and destroyed, until it is represented by a suppurating cyst with thick walls. Secondary infections generally take place sooner or later; the pus and urine become foul, and symptoms of septic absorption begin to appear. There is always a surrounding of dense (*perinephritic*) adhesions, and sometimes abscesses develop. When the ureter is attacked it becomes thickened, and at the same time shortened, so that it drags on the ureteral meatus, causing a pitting of the bladder wall at that point. Infection may spread to the bladder, and thence to the opposite kidney. Tuberculosis may arise secondarily in the kidney by extension from the bladder; or from the testis by way of the vas and vesicles; or by generalised tuberculosis: in these cases it is apt to attack both kidneys.

Prognosis.—The disease may exist for several years, but it is generally ultimately fatal. If confined to one kidney it may be eradicated by operation.

Symptoms.—There is frequency of micturition; pus, and occasionally blood, in the urine. Tubercle bacilli can sometimes be found, but they are apt to appear in scanty numbers, or only at intervals. The kidney is generally more or less enlarged, especially if the disease is of long standing. The ureteral meatus, when seen by the cystoscope, appears retracted. The general health fails, and the patient becomes wasted and anæmic; sweating and rigors are common, and the temperature is generally raised in the evenings.

Treatment.—When tuberculosis is confined to one kidney and involves the greater part of it, the whole kidney should be excised; bnt the function of the other kidney must be investigated to ensure that it is working efficiently. If both kidneys are diseased, neither should be removed, even if they only show fair working efficiency. Isolated nodules may be removed by curette, and abscesses opened, and the cavities drained and treated with iodoform.

Tumours.—**Carcinoma** occasionally occurs as a primary tumour: it is attributed sometimes to irritation of a calculus.

More frequently it is met with as a secondary growth following cancer elsewhere.

Sarcoma (at all times a rare tumour) is occasionally found in the kidney as a primary disease. It occurs in infants within the first months of life, or may even exist at birth. It runs an extremely rapid course, and is generally soon fatal. In adults, it is met with after the age of 30 or so; it grows rapidly, and reaches a great size, and from its bulk causes pressure effects. There is little pain as a rule, but hæmorrhage is common. (A rare form, *rhabdo-myo-sarcoma*, is met with, composed of muscular fibres and sarcomatous elements.)

Treatment.—In children, surgical treatment is usually of little avail. In adults, early extirpation is the only treatment: it may prolong life, and often prevents distressing symptoms from pressure, even when the whole disease cannot be eradicated.

Cysts.—Cystic degeneration is a congenital disorganisation of the kidney, produced by dilatation of the tubules, the origin of which is in dispute. The whole kidney is enlarged, and riddled with (*conglomerate*) cysts, which project as translucent nodules on the surface. It often affects both kidneys. The *symptoms* are formation of a tumour (following more or less uniformly the shape of the kidney), sometimes pain, with albuminuria or hæmaturia. The progress is slow; but if both kidneys are affected, always fatal in time.

Treatment.—Bilateral cystic degeneration is not suitable for surgical treatment; but if one kidney only is affected it should be excised.

Other Cysts.—*Small isolated cysts* appearing in granular kidneys, and simple serous cysts occurring in old people, are of no surgical interest. *Cystic dilatations* (hydro- or pyonephrosis) have already been treated of. *Hydatid cysts* are not very common; they form swellings similar in character and relations to hydronephrosis. They are treated by exposing the kidney, enucleating the cyst, and draining it, until the cavity dries up.

Supra-renal tumours and **cysts** are rare; and are most frequently of tubercular origin. From their proximity to the kidney they may be mistaken for renal affections. If a tumour is diagnosed as amenable to removal, the semilunar ganglion should be spared if possible. If the kidney is firmly adherent to the tumour, it must be sacrificed; and this is usually necessary when the lumbar incision is employed, owing to the want of room. If the anterior incision is used, it is sometimes possible to spare the kidney.

Wounds of the ureter may be made in removing calculi or in relieving strictures, or accidentally during operations (*e.g.* hysterectomy). Longitudinal wounds should be repaired by Lembert's suture; other wounds by anastomoses like those of the intestines. If a part has been removed for any reason, the upper end may be implanted into the other ureter (*van Hook's* method).

BLADDER.

Rupture of the bladder is discussed on page 386. It is often associated with **fracture of the pelvic bones** due to severe injuries (crushes, running-over, etc.). The fracture itself usually unites readily in the absence of complications, but laceration of the internal organs often proves fatal.

Treatment of fractured pelvis consists in keeping the patient in bed for 4 or 5 weeks; with a broad belt of adhesive strapping applied round the pelvis. If mobility still remains afterwards, a girdle-splint of poroplastic or leather should be worn. The bladder conditions must of course be carefully treated.

Wounds of the bladder which penetrate the peritoneum give rise to symptoms similar to those of rupture, and are treated in the same way. Those which penetrate the anterior wall only may be exposed as in suprapubic cystotomy, and the wound closed by suture. Wounds in the perineal aspect, are not amenable to suture, and should be drained, in order to prevent extravasation of urine into the soft tissues.

Extroversion of the bladder (*ectopia vesicæ*) is a congenital defect whereby the anterior wall is wanting. It occurs in males, and is usually associated with epispadias of the penis, and defects of the pubic bones. The posterior wall, with the openings of the ureters, is exposed, and often pouts outwards. The surface is almost always inflamed, red and soft; and the combined urine and mucous discharge is extremely irritating if allowed to remain in contact with the skin. Inflammation not uncommonly spreads to the kidneys, and causes fatal nephritis. In a few cases cancer has developed on the exposed and irritated mucous membrane.

Treatment.—The simplest treatment is to let the boy wear a kilt (which allows the urine to flow away at once), and live an open-air life. If this is unattainable, or for indoor use, a cup-shaped urinal may be strapped over the bladder surface.

Operations to close in the bladder are often futile, partly from the rudimentary size of the bladder wall, and partly from the inflammatory conditions which prevent healing. Many flap operations have been devised; but each case requires special adaptations. The most successful method of treating this defect is *Maydl's*, by which the ureters and the bladder wall to which they are attached are implanted into the upper part of the rectum, which often becomes tolerant to the presence of urine. The valvular openings, thus preserved, help to prevent the entrance of bacteria into the ureters: but fatal results from infection, by this route, are common. Attempts have been made also to *isolate* a piece of the sigmoid to form a new bladder, but without very encouraging results.

Fistulæ of the bladder opening externally sometimes follow operations for relief of obstructions or other conditions, and are either left purposely, or are maintained by the continuance of the obstruction, which prevents closure. Those opening into the intestine (or rectum) arise from ulceration of the walls of either organs, following tubercular or cancerous disease, or abscesses which open into both cavities. Those opening into the vagina (*vesico-vaginal fistulæ*) are generally the results of "ruptured perineum" in childbirth.

Treatment.—The last form is repaired by a flap operation, after freshening the edges. The others are often beyond operative treatment. External fistulæ tend to heal rapidly if all obstructions to the outflow of urine are relieved. When due to simple ulceration in the bowel, they may occasionally be repaired through a suprapubic opening. When due to malignant disease, irritation may be relieved by making an artificial anus, and so deflecting the fæcal stream from the bladder.

Incontinence of urine (involuntary escape of urine) may arise from malformations (epispadias, etc.); undue patency of the urethra, especially in females, from dilatation by calculi, or from injury; and to spasmodic contraction of the bladder muscles, due to spinal affections. It also arises as a result of over-distension (*false incontinence*). In children it often occurs spontaneously during the night (*nocturnal enuresis*) without any apparent signs of disease to account for it.

Treatment.—The urine should always be tested. Any source of irritation must be removed; and all causes of general debility checked. If the cause cannot be removed, a urinal of some pattern should be worn. Habitual incontinence in children can often be cured by breaking the habit. The child is wakened at intervals during the night to make water; and is encouraged to sleep on his side instead of on his back. In some cases passage of a bougie stops it at once.

Retention of urine in the bladder (*i.e.* inability to micturate) depends on *obstruction* to the outflow, from stricture (often accompanied by spasm and congestion), enlarged prostate, tumour, calculus impaction, or phimosis: *spasmodic closure* of the sphincter by reflex irritation following operations on the rectum, shock, or nerve injuries; or *atony* of the bladder from atrophy of its muscles, or from spinal or cerebral injury. In the latter condition retention gradually increases until the utmost capacity of the bladder is reached, when the weakened sphincter allows the excess of urine to dribble away (*retention-incontinence*). From the fact that subjective symptoms in this form are slight or absent, the overflow is the most conspicuous phenomenon; hence retention should always be suspected in the incontinence of old men. In the acute form the distension increases until the bladder can hold no more, when the back-pressure usually causes some check to urinary secretion (*suppression*). The bladder seldom ruptures unless injured by a blow; but the urine may escape through the posterior part of the urethra.

The **symptoms** are, extreme pain and distress; collapse, with faintness, cold sweats; and sometimes delirium, convulsions, or paralysis, of a uræmic nature. The bladder can be recognised, by palpation and percussion, rising above the pubes: (in the chronic form it may reach well beyond the umbilicus).

Treatment.—The bladder must be relieved without delay. Attempts should be made to pass catheters; flexible ones only being used in this condition (except in very skilful hands, when metal ones are allowable), and the coudé pattern adopted in prostatic cases. In extreme retention, if these means fail, the bladder should at once be punctured with a trocar plunged inwards immediately above the pubes (*paracentesis vesicæ*). Puncture through the rectum, prostate, or even the perineum, is not commendable. When retention is relieved, the contributing cause can be dealt with at leisure. Stones impacted in the urethra should be released by pushing them back into the bladder, or by external urethrotomy.

After-results.—Acute retention may cause permanent arrest of renal functions, and the patient may die of suppression and uræmia. In the chronic cases it is apt to induce interstitial nephritis. The bladder walls also may not recover from the overstretching of their muscular tissue, and permanent atony may remain. In younger and more vigorous men it may give rise to hypertrophy.

Hypertrophy of the bladder walls often takes place in order to overcome interference with the urinary outflow, especially in old-standing strictures and prostatic enlargements. The muscular wall is thickened as a result; and very frequently the intermuscular tissue becomes prolapsed between the hypertrophied muscular bands, thus forming *saccules*, which may be so large and deep that they may conceal calculi of considerable size. The feeling of such a sacculated bladder with the sound is usually characteristic.

Pouches in the bladder wall arise by the foregoing method; by atrophy of the walls from old age, or cystitis; or by prolapse of the trigone between an enlarged prostate and the interureteral ridge, under pressure; and occasionally as a result of ulceration.

Cystitis arises from direct infection following injuries; perforations in connection with the intestines or an abscess; or spread of inflammation of the urethra (*e.g.* gonorrhœa), or kidney; or suppuration of the prostate or seminal vesicles. It arises also in a bladder irritated by retention, calculus, or tumours, when the *residual* fluid becomes contaminated by microbes introduced either by spontaneous invasion along the urethra from the meatus, or by the passage of an unclean instrument, or, more often, of a sterile instrument through an uncleansed meatus. Cystitis seldom arises by the latter methods if the bladder can be completely emptied and well flushed out with a copious flow of urine; but it is very common in those suffering from paralysis of the bladder (*e.g.* in spinal affections), or retention (*e.g.* from enlarged prostate).

Acute inflammation comes on either suddenly or insidiously, with "*irritability of the bladder*,"—pain, inability to retain more than a small quantity of urine, and frequency of micturition.

The bladder is tender to palpation through the rectum or vagina. The urine contains pus, mucus, and epithelial cells, and sometimes even shreds of mucous membrane, and in very acute inflammations, blood. It may be alkaline in reaction; but if not decomposed, it is usually acid. There is seldom pyrexia, except when the adjacent organs (prostate, prevesical tissue, or kidneys) are involved.

Treatment.—Rest in bed, with light, unirritating diet; hot fomentations to the hypogastrium; and subcutaneous injections of morphine. *Weak* injections, into the bladder, of silver salts (nitrate of silver $\frac{1}{16}$ grain to the ounce, protargol, etc.), though causing smarting at first, sometimes relieve the pain. In very severe cases cystotomy and drainage may be required to give the bladder rest. Any obvious cause must, of course, be removed if possible.

Chronic cystitis either originates in an acute attack, or is chronic from the first; it is due to causes similar to those of acute cystitis. The bladder wall is thickened, and in old-standing cases may be hypertrophied to a high degree. The mucous membrane is sodden and grey-looking, and occasionally has minute abscesses or ulcers embedded in the surface.

The **symptoms** are the same as in acute cystitis, but milder in degree. The urine is generally decomposed, foul-smelling, or ammoniacal, and alkaline in reaction; and often contains a deposit of phosphates, and always some pus, and a considerable quantity of glairy mucus which is difficult to void. The constitutional effects are not very well marked, unless an acute attack supervenes; but usually the patient becomes wasted and anæmic, and worn out with the constant painful micturition. Life is always more or less in danger from the liability of pyelonephritis ensuing. Another, but much rarer, cause of death in these cases is acute ascending paralysis ("*urinary paraplegia*"), which seems to be due to spinal intoxication or inflammation, set up by the micro-organisms in the urinary system.

Treatment.—*Prophylactic measures* for those requiring constant catheterisation, etc. consist in rigid asepsis of the instruments used, cleansing of the penis and meatus with boracic lotion at each passage, and thorough emptying of the bladder. All known conditions likely to lead to cystitis should be treated when possible.

Remediary treatment consists of daily irrigation of the bladder with warm boracic lotion, and occasional injections of silver salts, to decrease the mucous secretion, and so prevent the aggregation of phosphatic particles into concretions. Decomposition is checked by internal administration of urotropine; acidity of the urine encouraged with benzoic acid; and irritability diminished with hyoscyamus and sometimes alkalis. In refractory cases the bladder should be drained through a suprapubic or perineal opening. Continuous irrigation is occasionally of use.

Tuberculosis is more common in men than in women. It arises most frequently from spread of infection directly from the kidneys or the testes, or indirectly from the lungs; but occasionally it seems to occur primarily. The bladder wall becomes inflamed and thickened, and the tubercles soon break down to form ulcers; sometimes scattered as minute pits over the surface, and sometimes as larger confluent erosions.

The **symptoms** are at first "irritability of the bladder," later blood and pus in the urine. Tubercle bacilli can often be detected; but, on account of their scarcity, a large quantity of urine should be collected and centrifugalised for examination. The symptoms of cystitis persist, and increase in severity, in spite of ordinary treatment. The bladder wall becomes indurated, and cannot be emptied; and occasionally perforations occur, with fistulous openings into the rectum (or vagina).

Treatment.—Constitutional treatment, with fresh air and abundance of food, is the most important. Locally, the cystitis must be dealt with as in other cases; and iodoform emulsion may be injected, or in females it may be rubbed into the ulcer, after dilatation of the urethra. If improvement does not take place cystotomy should be performed, the ulcers curetted, and the bladder drained.

Tumours grow most frequently about the trigone, especially around the ureteral and urethral openings. *Papillomata* occur either as pedunculated tumours or sessile growths, with villous projections from the surface. *Angiomata*, *myomata*, *myxomata*, *fibromata*, have all been met with, but they are comparatively rare. *Sarcomata* originating in the submucous tissue arise sometimes as primary tumours, rapidly infiltrating the bladder wall, and growing to great size. *Carcinomata* and *epitheliomata* are unfortunately frequent, forming indeed the commonest tumours in the bladder (at least benign tumours in this situation are specially liable to "take on a malignant character").

Symptoms.—After a period of latency without symptoms, the first to appear is hæmorrhage; this is slight and transitory in simple papillomata, but more persistent in cancers with soft surfaces, while infiltrating tumours do not bleed until ulceration takes place. Following this is "irritability of the bladder" from cystitis, mobility of a pedunculated tumour, or rigidity of the walls, accompanied by severe pain from infiltrating growths. In the malignant tumours ulceration ensues, with discharge of pus and blood, and sometimes of villous shreds and epithelial cells (which, however, may present no definite appearance of malignancy). Examination with the cystoscope is difficult on account of hæmorrhage; but this may often be checked by instillations of silver nitrate or adrenalin solutions.

Diagnosis.—The chief conditions which may be confused with vesical tumours are (*a*) calculus, (*b*) congestion of the prostate, and (*c*) hæmorrhage of renal origin.

Treatment.—All pedunculated or isolated tumours should be excised whether benign or malignant: the infiltrating tumours are generally past the stage of operation before diagnosis can be made. The bladder is opened above the pubes, and the tumour seized with a long forceps and drawn up, while the base is cut off the wall of the bladder. Should this be impossible on account of a fat abdominal wall, or fixity of the bladder, a "caisson" (*H. Fenwick*), shaped like a Fergusson's vaginal speculum, is pressed on to the posterior wall, enclosing the tumour; the urine is sucked out of it, and the tumour and base bitten away with cutting forceps. The wound usually bleeds considerably; and it should be treated with pressure until the hæmorrhage diminishes, and the bladder drained until it ceases.

Calculus in the bladder originates either as a small uric acid or oxalate stone of the kidney, which passes down into the bladder, where it grows by accretion of similar substances or deposit of phosphates; or it may commence in the bladder. Phosphatic stones are formed by decomposition of the urine associated with cystitis, and a deposit of ammonio-magnesium phosphates around a nucleus (calculus, blood-clot, foreign body, etc.). Laminated stones are formed by the intermissions of the inflammation, and consequent deposit of phosphates in patients who have a tendency to calculus-formation of other origin. Calculus development is commoner in men than in women, on account of the greater facilities for escape of renal stones from the female bladder. It occurs most frequently in older men, when retention and cystitis are more common; and in young boys, when the urethra is narrow, and even small stones are not easily passed. It is apparently induced by "gouty" tendencies, improper feeding, and want of exercise, and occurs readily in those suffering from retention and cystitis. It is also said to be more common in certain localities.

The **symptoms** are "irritability of the bladder," varying to some extent with the roughness of the stone; uric acid ones, being small and smooth, give rise to comparatively little disturbance, while oxalate ones, being heavy and nodular, cause great irritation. Along with this, the most characteristic sign is blood in the urine, generally represented by a few drops at the *end* of micturition, accompanied by a spasm of pain, when the stone is caught by the contracting bladder walls, and excoriates the mucous membrane of the trigone. If the stone impinges on the urethral opening it may cause sudden temporary stoppage of micturition. The pain is generally referred to the point of the penis, and is increased by any violent movement.

Examination.—The classical method of detecting a stone is by the sound (a solid metal rod with a short, sharply-curved beak), the bladder being examined when partly filled with urine or boracic lotion. The instrument is manipulated so as to feel the whole of the bladder; but if no stone can be felt, a guarded opinion should be given: it may be covered with thick mucus, encysted in a "pouch" or "saccule" of the bladder wall, or lying behind an enlarged prostate. The size of the stone may be gauged if desired by seizing it in a lithotrite. A very exact examination can often be made by means of a cystoscope; this cannot always be used in children on account of the smallness of the urinary passages, or in adults on account of stricture or enlarged prostate. In certain cases *Fenwick's suprapubic trocar* may be plunged into the filled bladder, and his straight sound and cystoscope passed through the canula.

Treatment.—The stone may be removed by crushing or by cystotomy. The former should be used in all cases, where it is not counter-indicated:—by narrowness of the urinary passages, great size of the stone, encysted situation, cystitis, and lack of skill on the part of the operator.

Lithotrity or *litholapaxy* (crushing of a stone). The bladder is filled with boracic lotion, and the pelvis raised. After anæsthesia is established the lithotrite is introduced into the bladder, the stone is caught, and crushed until it is reduced to a fine gravel. The lithotrite is withdrawn, and a large-sized catheter introduced in its place, through which the debris is washed out with streams of water injected backwards and forwards from a rubber bulb attached to it (*Bigelow's evacuator*); if the particles are too large to pass, the lithotrite must be used again. The bladder should be examined with the cystoscope (which in the newer forms can be introduced through the catheter), to insure that it is clear of debris, which if left would cause great irritation.

After-treatment.—If there is pain, opium may be given and hot hip baths. If cystitis develops it must be treated as in other cases. Rigors and fever are not uncommon after any manipulation of the bladder; they should be treated by administration of quinine and opium.

Lithotomy (cutting for stone) may be performed (1) above the pubes (now the most common method); or through the perineum (2) by median, or (3) lateral lithotomy.

Suprapubic Cystotomy.—The bladder is distended with warm boracic lotion or air, in order to bring the anterior wall near the surface, and also to raise the reflection of peritoneum out of the way of the incision. (A long curved sound is sometimes used for the same purpose, but is much inferior.) An incision is made immediately above the pubes, the soft tissues are separated, and the bladder is caught up with long forceps, and opened by plunging a knife straight in. The edges are at once hooked up, or fixed with stitches to the superficial structures, in order to prevent extravasation into the loose prevesical tissues. The stone is removed with the fingers, lithotomy forceps, or scoop. If there is cystitis the bladder should not be closed, but irrigated and drained with the aid of a siphon tube for a time; if the bladder is healthy, and there is no bleeding, the opening may be closed; but the stitches must not penetrate the mucous membrane, lest they should act as foreign bodies and form the nucleus of another calculus.

Perineal lithotomy is sometimes performed when there is cystitis, as drainage can be carried out so easily in this region. The patient is put in the *lithotomy position* (*i.e.* placed on his back, with the pelvis raised, and the thighs bent up on the abdomen and retained there by one of the various "crutches" for the purpose, or by tying the feet to the wrists). The *median* incision is made directly down on a grooved staff introduced into the bladder, entering the membranous part of the urethra. The finger follows the staff and enters the bladder by dilating the prostatic part through which the stone is extracted. The *lateral* incision is made in a similar way on a staff with a groove on one side (the left), and the prostatic part of the urethra alone is incised and dilated. If the stone is very large it may be broken before extraction. A tube is inserted for drainage, and packed round with iodoform gauze to prevent extravasation into the soft tissues. It should be left in until the condition of the bladder is improved, as the opening tends to heal very quickly once it is removed.

In **women** operation is seldom required; the urethra is short and distensible, and stones pass much more easily. If they remain in the bladder, however, they can usually be removed with forceps after dilatation of the urethra.

Foreign bodies are either tips of catheters or other instruments broken off in the bladder; or articles introduced by the patient for the purpose of clearing an obstruction or for other reasons, and comprise all sorts of things (hairpins, beads, grasses, etc.); and also substances entering the bladder after ulceration or injury of its walls. The general *symptoms* are those of cystitis; and if the body remains long in the bladder, the formation of a calculus round it.

Treatment.—The bladder should be viewed with a cystoscope to determine the size and nature of the body, which should be removed by suprapubic cystotomy. Soft articles, like rubber tubing, may be caught in a lithotrite and pulled out.

CHAPTER IX.

GENITAL ORGANS.

URETHRA AND PENIS.

Malformations. — **Epispadias** is a defect of the dorsal wall of the urethra, due to incomplete closure of the pelvic girdle. The penis is usually rudimentary; and the condition is very commonly associated with extroversion of the bladder; and nearly always with a deficiency of the sphincter, which results in intractable incontinence and consequent excoriation of the skin. It is often accompanied by double inguinal hernia.

Treatment.—The defect may be repaired by a double flap taken from the penis; one flap covering in the mucous urethra, and the other covering this new channel with skin. The incontinence is not improved by this means, and as operations for that purpose are not usually successful, a portable urinal must still be worn.

Hypospadias, a similar defect of the lower aspect of the urethra, is due to incomplete closure of the uro-genital sinus. It may consist of a small aperture just below the glans, where the urethra stops short without penetrating it; or of a division down the whole urethra to the perineum (which when associated with rudimentary development of the penis and non-descent of testes, gives rise to the condition of false *male hermaphrodism*). The penis is generally bound down by a fold of skin, which causes curvature of the organ on erection.

Treatment.—All adhesions on the lower side should be divided. Small apertures may be closed by freshening the edges, and closing them by suture. If the glans is not penetrated by the urethra, a new channel may be made by perforating it, and fixing in a narrow tube until the surface is covered with epithelium. Long open channels are closed by plastic operations, as in epispadias.

Foreign bodies in the urethra are either calculi passed from the bladder, or articles introduced through the meatus. If retention of urine occurs from impaction, an attempt should be made to extract the body with urethral forceps. If this is unsuccessful, it should be extracted through a small incision made down on to it, the wound being closed by Lembert's suture. A small calculus may sometimes be pushed back by means of a bougie into the bladder, where it can be dealt with later. Hat pins with round heads (which are generally introduced head first, and slip out of reach) may be extracted thus: the pin is gripped through the urethral walls and made to pierce them as nearly as possible at right angles to the canal, and then turned round so as to lie with the head pointing outwards, when it can easily be pushed out of the meatus.

Urethritis.—**Simple urethritis** sometimes occurs from injury due to blows or passage of instruments, from irritating lubricants or applications, or contact with leucorrhœal discharges, etc. The inflammation is mild and transitory; and the results (except from severe injuries) slight. *Treatment* is removal of the cause, and the general measures used in gonorrhœa.

Gonorrhœa (*gonorrhœal urethritis*) is described on page 37.

Diagnosis is made to a great extent from the history of infection, but in cases of doubt the microscopical appearance of the discharge is characteristic. The cocci are seen occasionally free in the fluid, but more typically in the leucocytes; they are decolorised by Gram's method (a circumstance which distinguishes them from *pseudo-gonococci*, which retain the stain).

Treatment in general is that of acute inflammations. Rest, as complete as is found possible, should be enjoined, with support of the testicles in a suspensory bandage; all possible sources of injury (riding, etc.), or of congestion (constipation, indulgence in alcohol, or stimulating foods), prohibited; and free flushing of the urethra by micturition, encouraged by the copious drinking of demulcent fluids. Care must be taken throughout to prevent inoculation of the eyes, or of other persons.

If the disease is detected within two days of inoculation *abortive treatment* may be tried, often with success; later than that it has little if any influence on the course of the inflammation. The urethra is flushed out by micturition, and, after cocainisation, a drachm or two of solution of protargol or silver nitrate (1 per cent) is injected until the urethra can hold no more; this is retained for two minutes or so by compressing the meatus. The injections are repeated daily for a week, after which time all signs of inflammation may have ceased.

If inflammation becomes *established* injections or irrigations are, as a rule, to be avoided, and treatment confined to administration of alkalis and diuretics to increase the flow of urine, and hyoscyamus for painful chordee. When the acute stage begins to subside and the discharge becomes more profuse, certain drugs have a beneficial effect in aiding mucous secretion (copaiba, sandal-wood oil, etc. 10-30 drops after meals). Irrigation or repeated injections of weak lotions (pot. permang. 2 per cent, zinc sulpho-carbolate 0·1 per cent) are often prescribed at this stage, or soluble bougies containing iodoform or eucalyptus may be introduced into the urethra; but if used at all they should be reserved until all scalding pain has ceased.

In the later stages, if cure does not take place, the disease sometimes becomes very intractable, and the condition of **chronic urethritis** with persistent slight discharge (**gleet**) remains. It is often maintained by a general catarrhal thickening of the mucous membrane, especially if irritating injections have been used; or by small ulcers, often associated with slight strictures which are kept from healing by spasmodic contractile movements. The former are treated with the astringent injections or irrigations mentioned above; the latter by the passage of a large bougie to dilate the stricture, followed by direct local application of a stimulating agent (picric acid, tinct. iodi, etc.) through a urethroscope (an instrument which is invaluable also for detecting the condition of these intractable cases).

Prognosis.—Sometimes a discharge may last for years, either persistently or intermittently; and although no gonococci can be detected on examination, recrudescence of inflammation of any origin usually causes the gonococci to reappear. The danger of infecting a wife by this means is obvious; and the results (pyosalpinx, sterility, chronic invalidism, etc.) are often disastrous. The injection of a 5 per cent solution of silver nitrate usually induces such an attack of inflammation, accompanied by a profuse discharge containing cocci; and this measure sometimes finally cures the condition.

Complications of gonorrhœa are mentioned on page 38. The chief local ones are *chordee*, *balanitis*, *epididymitis*, and occasionally *bubo*; while of the later effects *stricture* is the most frequent and important.

Chordee is a painful erection of the penis which comes on usually when the patient is warm in bed. It is attributed to inflammatory thickening of the corpus spongiosum, which is thereby prevented from expanding in concert with the corpus cavernosum, and by its traction causes the penis on erection to become bent or twisted. It is *treated* by relaxation of the bowels, local application of cold, and internal administration of opium or hyoscyamus.

Cowperitis (inflammation of Cowper's glands, situated between the layers of the triangular ligament) is a somewhat rare complication of gonorrhœa. It is attended with severe pain and fever, and may proceed to abscess formation. It is *treated* by general antiphlogistic means; and, if suppuration takes place, it should be relieved by deep perineal incisions.

Stricture occurs from cicatricial contraction of the submucous tissue surrounding the urethra, following injuries (*traumatic stricture*) from blows, falls on the perineum, unskilful passage of instruments, etc. or, much more commonly, following gonorrhœal inflammation; and occasionally after simple urethritis or an intra-urethral chancre. A congenital form is also described, in which the stenosis may attain even to "*imperforate urethra*," situated usually about the meatus.

Strictures may be single or multiple, and situated at any part of the urethra except the prostate, but found most frequently in the bulbous portion immediately in front of the triangular ligament; those in the anterior part being often accompanied by others farther back. They may be of various shapes (*annular*, *bridle*, *tubular*, *tortuous*, etc.); and of any degree, even to the point of *impermeability* (*i.e.* when urine can no longer pass), or *impassability* (*i.e.* when instruments cannot be introduced); and of different consistencies (*fibrous*, *elastic*, or of such hardness that it is often spoken of as "*cartilaginous*"). The presence of a stricture increases any tendency to contractile closure, and may produce a spasm which in some cases is more prominent than the organic stenosis (*spasmodic stricture*). This should be distinguished from purely functional urethral spasm following operations or other irritation of the "pudic area." The *results* of chronic obstruction in the urethra are mainly those of pressure. The urethra behind the stricture is apt to become dilated, with the formation of a pouch which may be the seat of ulceration, or rupture on sudden straining, leading to extravasation of urine. Further, back-pressure may react on the bladder, and lead to muscular atrophy or hypertrophy, or cystitis; or on the ureters and kidneys, leading to hydronephrosis or nephritis. The constant straining is apt to induce hæmorrhoids or prolapse of the rectum.

The **symptoms** generally come on gradually, with increasing difficulty and slowness of micturition; the stream, which is often twisted, becomes progressively smaller, until finally the urine only comes away in drops on extreme straining. Sometimes the first sign is an attack of retention following indiscretion in drinking or exposure to cold, which causes spasm and congestion in the already narrowed urethra.

The urethra is *examined* for strictures by means of bougies; the least harmful and often the most efficient being flexible and tapering, and furnished with an olivary bulb at the point. Failing those, and in refractory cases, Lister's bougies, of similar form, but made of metal, are useful. They should be warmed and well oiled, in order to prevent spasm or friction. The larger sizes should be tried first, as too narrow a point is apt to catch in a lacuna or fold of the mucous membrane, and give fallacious information as to the position of the stricture. Catheters should not be used for this purpose, as the eyes are apt to do damage to the mucous membrane. The *situation* of a stricture is gauged by the distance traversed before it is entered; the *extent*, by the passage through it of the bulb, which is then no longer clasped tightly by the urethral walls; and the *consistence*, by its dilatability when the conical part of the bougie enters it. In cases of difficulty a urethroscope should be inserted, and filiform bougies passed through the narrow part under direct vision.

The *chief dangers* of passing instruments are hæmorrhage, from laceration of the mucous membrane, or from false passages; urinary fever; and extravasation, and urinary fistulæ.

Treatment of Stricture.—Dilatation.—*Gradual dilatation* is the most suitable method for all ordinary strictures of mild degree. A bougie, as large as can be passed without difficulty, is left in for a few minutes; and this is repeated once or twice a week, with a larger instrument each time, until the full size is reached. In this way little irritation is caused, and the patient does not require to lie up. *Rapid dilatation* is performed when time is an object; it is done in the same way, but the larger instruments are passed in rapid succession as soon as the smaller ones are withdrawn, an anæsthetic being used if required. In this method especially, owing to the tendency to relapse, the highest ordinary English size (12) is not sufficient, and number 16, or 14 at least, should be passed before the surgeon is satisfied. For the following month or so a large bougie should be passed weekly, afterwards at longer intervals, in order to maintain the good results obtained by the operation. In very small strictures *continuous dilatation* is often used, the patient being confined to bed meanwhile. A fine catheter is passed and tied in, and replaced by a larger one as often as it becomes loosened (by absorption of the surrounding tissues, due to the continuous pressure). This is continued as long as the patient can bear it, or until the larger instruments suitable for rapid dilatation can be introduced. (*Divulsion* with Holt's apparatus, by which the stricture was violently torn asunder, is now abandoned, as it generally gave rise to such extreme cicatricial contraction afterwards.)

Urethrotomy.—*Internal urethrotomy* is performed with one of the instruments made for the purpose, containing a concealed knife which can be extruded at will to cut either from before backwards (*Maisonneuve's urethrotome*), or from behind the stricture forwards (*Civiale's*). The incision should be deep, as even "cartilaginous" strictures are very elastic, and slip under the knife; but it should be restricted in length to the cicatricial tissue only, or profuse bleeding may result. The after-treatment is the same as in dilatation. *External urethrotomy* is the most satisfactory operation when a stricture cannot be cured by dilatation. When the stricture is in the posterior third, and the urethra obviously patent, *Syme's grooved staff* is introduced into the bladder, and an incision is made by carrying a knife down to it, and along the groove into the bladder. A large catheter is passed into the urethra and bladder and tied in, and the urethral wound is allowed to heal by granulation. When the stricture is "impassable," *Wheelhouse's grooved staff* is introduced as far as it will go, and an incision made down on the groove to the site of the stricture; the edges of the cut urethra are retracted, and a narrow director (or Wheelhouse's probe-gorget) passed into the orifice, and the stricture freely divided on it. *Cock's operation* is urethrotomy without a guide, and, though more difficult to carry out, is useful in cases of emergency when the bladder has to be relieved, and is rendered easier when the urethra is dilated behind the stricture. In favourable cases urethrotomy may be combined with resection of the strictured part, and the cut ends sutured together (**urethrectomy**). When too great a length is resected to allow of union, a *graft* composed of a calf's urethra has been inserted with satisfactory results (*Pringle*).

False passages are channels made into the tissues alongside the urethra. They may be recognised when the instrument is found to be travelling out of its line; when a sensation of grating or obstruction is felt; and when free rotation of the point is impossible after penetration to the distance calculated to reach the bladder. Should a catheter enter a false passage, the urine, of course, will fail to flow; but as this may be due to clogging of the eye with blood-clot, it should be cleared out with a stilette. The *results* are sometimes serious:—extravasation of urine with all its consequences; abscess, or cellulitis in the perineal tissues, spreading to the abdominal wall or to the peritoneum, etc. Sometimes healing takes place; but usually a depression is left at the former opening of the false passage, affording ample opportunity for instruments to re-enter and open it up.

Urinary fever is not uncommon after simple passage of an instrument, even without active disease of the urinary organs. It is due either to reflex irritation, or to septic absorption. In the commonest form there is a single rigor and rise of temperature (103°-105°), accompanied by headache and malaise, but falling to normal permanently in a few hours. In the more serious form it may recur several times, or remain persistent; it is then due to septic absorption of considerable degree, or to disease of the kidneys.

Treatment.—In the mild form quinine and opium, with hot drinks and warm coverings, are usually sufficient to subdue the unpleasant effects. When a patient subject to such attacks requires any instrumentation of the urethra a prophylactic dose of quinine should be given. The graver forms are treated like infective inflammations of the kidney.

Extravasation of urine takes place usually from wounds, or rupture of the urethra following stricture, but may happen from any violent injury when the bladder is distended. The perforation is situated either behind the triangular ligament, when the effects are those of rupture of the bladder; between the two layers, when the effects are localised, and often proceed to abscess, with inflammatory fever and "pointing" in the perineum; or in front of the triangular ligament, when the urine is effused into the scrotum, penis, and abdominal wall, but is prevented from travelling backwards or down the thighs by the attachment of Colles's fascia.

The **symptoms** in the last form usually begin with a sudden feeling of relief during painful distension of the bladder. This is followed shortly after by itching or burning pain in the scrotal region, spreading upwards on the abdomen, sometimes as far as the axillæ, and accompanied by puffiness and discoloration of the skin. Ulceration and sloughing may take place; but if the urine is already foul, the constitutional results from septic absorption in untreated cases are sometimes so great that death occurs before this happens.

Treatment.—A catheter should be passed, if possible, to prevent further extravasation; otherwise the bladder may be drained by an incision. In any case, numerous and free incisions must be made for drainage into the penis, scrotum, and perineum, and as far up on the abdomen as the effusion has spread. Stimulating treatment of every kind is necessary in these cases, owing to the great depression caused by the poisonous absorption.

Urinary fistulæ are generally the result of abscesses, extravasation of urine, or wounds. They are kept open by some obstruction in the urinary channel, removal of which usually leads to rapid healing, especially if the edges of the fistula are freshened. Irregular burrowing fistulæ resulting from spreading inflammation should be laid freely open, and allowed to heal by granulations.

Phimosis is congenital stenosis of the prepuce, which in extreme cases may prevent micturition except in a small stream, thus causing ballooning around the glans, and back-pressure on the bladder and kidneys. In slight cases it causes no ill effects, and requires no treatment. Along with phimosis the prepuce is frequently found to be *adherent* to the glans, and this combination sometimes gives rise to a reflex spasm of the urethra, which sets up straining, and may encourage the development of a hernia.

Treatment.—Adhesions of the foreskin without phimosis sometimes disappear spontaneously, but they should be separated by stripping the glans, and keeping the surfaces apart with thin strips of oiled lint. Phimosis is treated by **circumcision**, the redundant prepuce being clamped in forceps or in a narrow slit in a metal plate, to guard the point of the glans from injury. In older children, at all events, the cut edges of the skin should be sutured, and the few bleeding points tied. No dressing is applied, but the parts (which must be previously made aseptic) are smeared with sterile or carbolised oil, and protected from sticking by a covering of oiled waterproof.

Paraphimosis is retraction of a stenosed prepuce behind the glans, where by its constriction it causes great œdema, and further difficulty to reduction, and if not relieved in time, deep ulceration. It often occurs in the course of gonorrhœa, and the inflammatory swelling greatly aggravates the condition.

It is **treated** by lubricating the parts, and pushing the glans back into the prepuce, after squeezing it to reduce the swelling. If this fails, the foreskin must be freely divided on a director.

Balanitis is inflammation of the glans, with redness and excoriation of the surface, and swelling of the prepuce. It is treated by frequent cleansing and application of astringent lotions (lead acetate, etc.).

Epithelioma occasionally occurs on the penis; commencing either on the edge of the glans, or the prepuce, as small, warty, sessile growths, which soon ulcerate. It may be distinguished from a primary chancre by the age of the patient, the history of its onset apart from venereal infection, the absence of such "cartilaginous" thickening of the base, and the comparatively late implication of the lymphatic glands.

Treatment.—If seen early enough, the penis should be amputated; the edges of the urethra being sutured to the skin, and the inguinal glands excised, whether enlarged or not.

SCROTUM.

A congenital **abnormality** is sometimes seen, *bifid scrotum*, each half containing a testicle. It is usually associated with other defects of those parts.

The **scrotal skin** is liable to various diseases. *Eczema* is frequent, on account of the exposure to friction and moisture. *Œdema*, when it occurs, is very marked, on account of the looseness of the tissues. *Elephantiasis* is fairly common in those countries where it is endemic. A form of *epithelioma* is sometimes met with, called "**chimney sweeps' cancer**," because of its frequency amongst those who work amidst soot, coal, etc.; it begins as a small, warty, sessile outgrowth, which gradually extends and ulcerates, and soon involves the deeper structures and the inguinal glands.

Hydrocele is a collection of fluid in the tunica vaginalis of the testis, or its prolongation in the cord. The *causes* are uncertain; but congestions of the spermatic veins of any origin, and injury, are certainly predisposing. The fluid is transparent and pale yellow in colour, and contains albumen, and, in cases of long standing, cholesterine.

Symptoms of Hydrocele of the Tunica Vaginalis.—The scrotum is distended with a firm swelling, composed of the vaginal sac expanded with fluid; it is translucent to bright transmitted light, except in old-standing cases, when the walls are thickened, and may be even calcareous. The swelling is not reducible; it is usually fluctuant on percussion; it does not alter in size or tension with change of position; and there is no impulse on coughing. It grows from the bottom of the scrotum upwards; and the cord lies free from the swelling.

Hydrocele of the cord may be encysted or free. In the **encysted** form the symptoms are similar to the preceding; but the testicle is felt separate below; the swelling extends up towards the ring, and may even penetrate the canal; and the cord is intimately connected with it. In "**congenital**" **hydrocele of the cord**, the *free* form (*i.e.* where there is an opening into the abdomen), the symptoms differ, in that the swelling is reducible both on pressure and on lying down, and returns on standing up; and there is an impulse on coughing (slightly less than that of hernia). Congenital hydroceles are not infrequently associated with hernia, forming then "*hydroceles of the sac*"; and sometimes with varicocele: hence the diagnosis is complicated by the presence of either of those conditions. Hydrocele of the cord may be *combined* with that of the tunica vaginalis, and may be either encysted or "congenital," partaking of the characters of both hydroceles and both forms.

Diagnosis of these and other scrotal swellings is given on p. 435 (*Hernia*).

Treatment.—Palliative treatment consists of removal of the fluid by tapping (*paracentesis*). In mild cases, especially those following traumatic inflammation, this is sometimes sufficient to cure the condition permanently. If the fluid reaccumulates it may be tapped as often as it causes distress.

Radical treatment consists in obliterating the sac, by (*a*) injection of an irritant fluid after tapping, to set up adhesive inflammation, which unites the contiguous layers. For this purpose a mixture of the liniment and tincture of iodine (1 drachm of each) is the most suitable; if too weak an irritant (such as tincture of iodine alone) is used, the hydrocele may return. (*b*) The sac is split in front, loosened at the side, and folded round to meet at the back of the testis, where it is fixed with a suture. Or (*c*) the sac is laid open, and the parietal layer dissected off. The last of these methods is nearly always successful; while the second, though more easily and quickly carried out, occasionally results in recurrence, notwithstanding that the serous surfaces are turned against other tissues.

Hæmatocele is effusion of blood into the tunica vaginalis. It arises from injuries (blows, paracentesis, etc.), and occasionally follows strains. It comes on rapidly, and is generally accompanied by pain, and extensive ecchymosis and œdema of the scrotum. The swelling is soft, and fluctuant or boggy, or, if very profuse, tense and elastic; it is opaque to transmitted light; and of course not reducible, or affected by coughing.

Treatment.—Slight effusions are treated by rest, elevation of the part on a pad between the legs, and local application of cold. In favourable cases the blood eventually becomes absorbed, unless it is in large amount, when it breaks down to form a cyst. In severe effusions the sac should be laid freely open, the clots removed, and any bleeding points secured, after which the wound is closed, with drainage for two or three days.

TESTIS—CORD—VESICLES.

Misplacements of the testis of varying degree are sometimes met with: (*a*) intra-abdominal (*cryptorchism*); (*b*) in the canal (*retained testis*); (*c*) outside the external ring, but not down in the scrotum (*undescended testis*); or (*d*) in abnormal positions, such as the perineum, etc. (*ectopia testis*). The intra-abdominal forms require no special treatment. In the other forms, however, the testis is much exposed to pressure and injury, and may become inflamed or strangulated. Those retained about the canal are often accompanied by hernia. Such testes are usually incompletely developed, and, further, have apparently a special liability to become malignant. For these reasons they should be removed (**castration**). An undescended testicle which tends to slip back into the canal may be prevented from doing so by wearing a U-shaped truss, adapted to hold it in position without pressing on the cord. If this is unsuccessful the testicle should be removed (except in young children, in whom the abnormality sometimes is cured spontaneously). Attempts to fix it in the bottom of the scrotum by suture are not very successful.

Torsion of the cord sometimes occurs if the testis hangs free with a mesorchium in the scrotum. If the vessels are constricted the testicle becomes strangulated, or in minor forms atrophied. The *symptoms* are pain, tenderness, and increasing swelling; vomiting and collapse, and sometimes fever; and rotation of the testicle, so that the epididymis is felt in front instead of behind. It is *treated* by making an incision, and in mild cases untwisting the cord, but in severe cases removing the testis.

Inflammation of the testis and epididymis. In the **acute** form, the former (**orchitis**) sometimes arises in the course of an attack of mumps (probably through metastatic infection): the latter (**epididymitis**) is most frequently an accompaniment of gonorrhœa (most probably through direct infection along the vas deferens). It also occurs, but much less commonly, from spread of inflammation of the bladder, and from gout and other general conditions. Though inflammation of the testis often spreads to the epididymis, the reverse is rarely the case. The results are effusion and swelling of the tissues, with blocking of the tubules. It either proceeds to suppuration, or eventually subsides, with absorption of the effusion. It is often accompanied by inflammatory exudation into the tunica vaginalis ("*acute hydrocele*"). In prolonged or recurrent inflammation absorption is not complete, and nodules of cicatricial tissue are left, which (in the epididymis) may be felt as hard lumps.

Symptoms.—There is swelling with tenderness in the scrotum; intense pain in the testis, cord, and inguinal region. When the inflammation is located chiefly in the body of the testis the pain is specially severe, on account of the inexpansibility of the tunica albuginea; when confined to the epididymis a round swelling is felt at its lower part (globus minor). There is generally considerable fever and constitutional disturbance. When orchitis occurs in the course of gonorrhœa or gleet, the discharge from the urethra often ceases at the height of the inflammation, but returns when it subsides.

Treatment is rest in bed, with support to the testis; and evaporating lotions, or hot fomentations, whichever are found to give most relief. The bowels should be opened, and diet confined to fluids as long as digestive disturbances continue. For the intense pain opium may be given internally, while belladonna may be applied locally on plasters. If suppuration occurs the pus should be let out without delay at the point where it forms.

Chronic Orchitis is generally a consequence of incomplete resolution of an acute attack. Chronic swellings which begin as such are generally tubercular or syphilitic.

The chief **signs** are dull pain and heaviness, with occasionally effusion into the tunica vaginalis, and swelling from proliferation of the interstitial tissues. This hypertrophy produces hardened nodules in the epididymis, or general enlargement of the testis; in either case it may lead eventually to atrophy, or cicatricial occlusion of the seminiferous tubules, thus rendering them functionally useless, and sometimes giving rise to *spermatocele.*

Treatment is support in a suspensory sling; mercurial ointment, or strapping, to aid absorption; and potassium iodide and tonics internally.

Tubercular disease generally begins in the epididymis at the upper part (globus major), and thence spreads to the globus minor, vas, seminal vesicles, and sometimes the bladder; and often to the body of the testis. Less commonly the testis is affected secondarily to tuberculosis of the bladder, prostate, or kidney, by transmission down the vas. It is common in early adult life, and is not infrequently associated with tubercular disease of the lungs.

Signs.—It usually commences with a hard nodule in the epididymis, which slowly increases, and eventually softens and breaks down. It is almost painless throughout. It involves the adjacent structures, and frequently breaks through the skin, to form indolent sinuses, or if the body of the testis is exposed, a soft fungating protrusion (*hernia testis*). When it ruptures into the tunica vaginalis a *spermatic hydrocele* is formed. The disease spreads up the cord by way of the vas, and also of the lymphatics, producing nodules scattered continuously or separately along it. When the body of the testis is attacked it becomes more or less uniformly enlarged, and soft and boggy, or hard and calcareous. In the late stages the seminal vesicles may be felt, by rectal examination, as thickened masses on the base of the bladder.

Treatment.—When the testis is destroyed, it should be removed along with as much of the cord as is diseased and accessible. When the disease is confined to one testicle, and is fairly diffuse, castration is indicated; when it progresses slowly, and the vas and vesicles are not involved, an attempt should be made to save the organ by palliative and constitutional means, with support by a suspensory bandage, and avoidance of all exposure to injury or inflammation. Localised nodules may be injected with iodoform emulsion; or if broken down, thoroughly curetted and packed with iodoform gauze.

Syphilis occurs either in the secondary stage as generalised infiltration, confined mainly to the body, and affecting both testes; or in the tertiary stages as gummatous masses, chiefly in the body, but occasionally in the epididymis, and generally unilateral. In the secondary form, if treatment is delayed, the structures of the testis become embedded in cicatricial tissue and undergo atrophy and shrinking; if successfully treated the infiltration may be completely absorbed.

Symptoms.—The testis increases slowly in size to form a tumour, sometimes of considerable magnitude. There is usually no pain; indeed, sensation on deep pressure is often dulled or abolished. In the secondary form the swelling is uniform, and does not lead to caseation or involvement of the skin, at least for a long time. In the gummatous form it may break down and fungate, as in other localities.

Treatment is mainly constitutional; mercury in the secondary stage, and potassium iodide in the tertiary. In addition, any fluid in the sac is tapped, and all abscesses opened as they form. The testis is strapped and supported in a sling, and mercurial ointment may be applied as a local resolvent. In the late stages, if disorganisation or deep ulceration takes place, the testicle may be removed, with advantage to the general health.

Tumours.—**Benign** tumours of the testicle are rare, but *adenomata*, *fibromata*, *enchondromata*, *myomata*, and *osteomata*, have all been recorded.

Malignant.—**Carcinoma** develops in the body of the testis; beginning as a uniform swelling, conforming to the shape of the organ, but ultimately becoming irregular, and involving the skin. Pain may be absent at first, but afterwards becomes very severe, and is accompanied by dragging on the cord from the increasing weight of the tumour. The lymphatics and glands become implicated, and general cachexia becomes marked. **Sarcomata** are sometimes met with in younger persons. They are of various consistences and compositions, and are subject to cystic and other degenerations. They begin as hard nodules, and grow slowly at first without pain, displacing the normal gland to one side; but afterwards taking on a more rapid and painful development. The skin is often involved, and breaks down, leaving a fungating, bleeding mass exposed. The cord becomes invaded, and forms a tumour leading up towards the groin. Malignant tumours of **mixed** elements, or of atypical epithelial growth, are of great interest from their pathological relationship with endotheliomata and chorion-epithelioma; but, fortunately, they are of rare occurrence.

Treatment of tumours is castration, and if malignant, removal of all accessible glands in the neighbourhood as early as possible.

Cysts.—(*a*) **Retention cysts** are formed by the occlusion of the seminal tubules, either from congenital causes (persistence of Wolffian bodies—paradidymis, etc.), or from cicatricial stenosis following inflammations. They appear generally in the epididymis, rarely in the body of the testis; and eventually tend to occupy the lower pole, rotating the testicle by their weight, so that it lies above. The contents vary in character; in recently developed cysts in adults the fluid is opalescent, and contains spermatozoa (**spermatocele**); in congenital cases in the young, and cases of long standing in adults, the fluid is clear and mucoid, and spermatozoa are absent, on account of the anatomical relation in the former, and from atrophy of the sac walls and degeneration of the contents in the latter. They are of slow growth, and as a rule quite painless. The best treatment is incision and removal of the whole sac.

(*b*) **New-formation Cysts.**—*Cysto-fibroma* (a benign cystic tumour, forming a single moderately-sized cyst), and *cysto-sarcoma* (a malignant tumour producing a multiple cystic condition, scattered throughout the testis), are in some respects related. In either case the testicle should be removed as soon as possible, on account of the possibility of the benign tumour taking on a malignant character.

(*c*) **Hydatid** (*echinococcus*) **cysts**, though occasionally met with, are rare in this situation.

Varicocele is a varicose dilatation of the veins of the spermatic cord (pampiniform plexus). The origin of the condition is still obscure; but there is probably a congenital predisposition, and after the age of puberty it is provoked by congestions and obstructions of various kinds. It is more common on the left side, a fact which is attributed to the absence of valves in the spermatic vein of that side, and to other anatomical differences; but a certain degree of varicosity may often be noticed on the opposite side.

Symptoms.—These are frequently entirely absent; but there is often a sense of weight and dragging, neuralgia of the testis, and in severe cases, extreme pain and atrophy of the testicle. Various phases of hypochondriasis are also met with, but their association with varicocele is often accidental. On examination the swelling is seen uniformly distributed along the cord, or confined to the lower part of the scrotum; it is usually soft and compressible; it disappears on lying down, and returns on standing up, even though the ring is obturated with the finger-tip; and it is little affected by coughing or other strains. The swollen veins, in their dilated state, feel like "a bag of worms."

Results.—The disease is often harmless, but it tends to increase after excessive exercise or on exposure to great heat. Any increase of congestion or strain may give rise to swelling and neuralgia; and from this fact malingering is facilitated when such conditions exist; hence the requirements of the public services often demand that a candidate for admission should undergo surgical treatment for varicocele (and varicose veins elsewhere) before appointment. Atrophy of the testis is rare, except when the veins of the organ itself are involved in the dilatation.

Treatment.—Palliative and general treatment consists in improving the bodily health, and any tendency to laxity of the parts, by moderate exercise, cold bathing, avoidance of all indiscretions in food, drink, or sexual excitement; and, in hypochondriacal cases, by tonic and moral means A suspensory bandage should be worn, but any undue constriction should be avoided.

Radical treatment of various kinds have been in use (*e.g.* removing the redundant skin of the scrotum, or drawing it through a ring, to raise the testicles); but the only method now recommended is *resection* of the veins. An incision is made over the cord near the external inguinal ring, the veins are separated from the vas deferens and its own particular vessels, and drawn well out of the wound until the testicle appears; they are ligated at the extremities, and the intermediate portion cut away. Some surgeons recommend tying the extremities together by the ends of the ligatures; but this is apt to make them slip, and also rather favours the regeneration of the veins, in which .varicosity may again appear. Others unite the perpendicular incision in a transverse direction in order to raise the bottom of the scrotum; but, owing to the elasticity of the tissues there, this is of little use, and the scar is never so satisfactory. The prognosis in this operation is usually very good; but cases are occasionally recorded in which dilatation recurs, neuralgia persists, or atrophy of the testis supervenes.

Seminal Vesicles.—Inflammation (*vesiculitis*), acute or chronic, occurs sometimes from gonorrhœal, or other infective inflammation about the bladder or prostate. The *symptoms* are similar to those of prostatic inflammations, but blood-stained seminal emissions are more likely to occur. It is treated in a similar way.

Tuberculosis of the vesicles is common as a complication of tubercle affecting the testis or cord, but is rare as a primary disease. It may be detected by rectal palpation, when the vesicles are felt beyond the prostate as swollen, pulpy, or calcareous tumours, pressure on which may cause discharge of pus in the urine. *Treatment* in secondary cases is generally only palliative. If diagnosis is made of primary tuberculosis the vesicles should be exposed, and removed by resection or curetting, through a perineal incision with wide retraction of the wound.

PROSTATE.

Prostatitis.—Congestion is occasionally met with in young men from excessive venery. In this form the prostate is swollen, and is liable to bleed, sometimes to a considerable amount.

Acute prostatitis occurs generally as a result of gonorrhœa, occasionally of cystitis, and sometimes follows injury (by catheters, calculi, etc.). It also arises apparently spontaneously in gouty individuals. It may go on to the formation of an abscess (*prostatic* or *periprostatic*) which bursts either into the bladder, or in the perineum, or in mild cases it may become resolved.

Signs.—Frequent micturition, with pain and tenderness, increased by pressure of any kind in the rectum (palpation, defæcation, etc.). There is generally some fever, with rigors and other signs of inflammation. On rectal examination the prostate feels swollen and hot, and if suppuration has taken place it may be pulpy or even fluctuant; and on catheterisation pus may come away with the urine.

Treatment.—The bowels are kept relaxed to prevent irritation from the passage of hardened fæces. Tenderness and pain may be relieved by hot fomentations or hip baths and opium suppositories. Abscesses should be opened by perineal incision as soon as diagnosis is made.

Chronic prostatitis arises either from the foregoing, or is chronic from the beginning. There is a discharge of clear or milky fluid, especially on defæcation, pain in the urethra, sometimes difficulty of micturition, and occasionally nocturnal emissions. The bodily and mental health suffers considerably in these cases.

Treatment.—The disease is often very refractory to treatment: any contributing cause must be corrected; the general health must be restored as much as possible; and riding, sexual indulgence, highly-spiced foods, alcohol, etc., must be forbidden. The passage of a large bougie, application of astringent ointments, or cautery with silver nitrate, are all recommended; and if one is not successful, another should be tried.

Tubercular disease is generally secondary to that of the seminal vesicles and epididymis. It causes nodular swellings in the prostate, which ultimately become either caseous or calcareous. There are general signs of bladder irritation, sometimes tenderness of the prostate, and often a discharge of blood and pus from the bladder.

Tumours.—*Carcinoma* and *sarcoma* are both rare, but are occasionally met with. The *symptoms* are similar to those of simple hypertrophy; but there is severe and constant pain, and a discharge of blood. The lymphatics of the groin and pelvis are often involved; and there is cachexia, with great failure of strength. *Treatment* is purely palliative, with drainage of the bladder when obstruction becomes pronounced.

Prostatic calculi sometimes occur as small granules of inspissated secretion in the gland, on which phosphates are deposited. They may make their way to the surface, where they set up irritation of the bladder. Calculi may also appear in the prostate, by a vesical calculus ulcerating into it. *Treatment.*—If large they should be removed by cystotomy; those occupying the substance of the gland seldom give rise to any signs, and do not therefore require special treatment.

Prostatic hypertrophy (senile enlargement) is a fairly common affection of old men. It arises from increase of the glandular substance and also of the interstitial fibro-muscular tissue, resulting in the formation of an adenomatous or fibrous tumour according as either tissue predominates. It usually produces a large, smooth, firm, and elastic swelling, enlarging upwards, and encroaching on the bladder at the neck, so that a depression is formed on the base behind it. Sometimes it forms a comparatively small tumour, which, however, is very firm and dense, and intimately adherent to the surrounding structures. Normally the fibro-muscular capsule derived from the pelvic fascia cannot be separated from the gland; but in hypertrophy a loose sheath is developed from which the prostate is readily shelled out. The enlargement may be uniform, or the one side may grow more quickly than the other; or the middle portion (although it has no special tendency to enlargement), taking part in the general hypertrophy, may be projected forwards to form a "*middle lobe.*" The urethra passing through the substance of the prostate is affected by any distortion and lengthening of the canal, and in addition, is compressed laterally by the encroachment of the elastic tumour all round it; further, the "middle lobe" may produce a barrier at the neck of the bladder, and if pedunculated may act as a ball valve, and obstruct the exit of urine. From these circumstances it is difficult to empty the bladder; and it generally happens that a certain amount of urine is habitually left at the end of micturition (*residual urine*), which naturally tends to decompose, if any germs gain admission; and to give rise to cystitis, deposit of phosphates, or formation of a calculus. When there is much obstruction at the vesical orifice considerable pressure of the bladder muscles is required to overcome it, and this usually causes hypertrophy, and often some sacculation; less commonly hydronephrosis or other results of back-pressure on the kidneys. In the later stages complete or partial retention is common; and sometimes false incontinence, with dribbling away of the excess urine.

Symptoms.—In many slight cases it gives rise to no disturbances, or at most a slight slowness of micturition; and the size of the prostate is no exact criterion of the degree of its interference with function. In pronounced cases micturition is difficult and requires great muscular efforts; and, finally, retention may become established, requiring relief with the catheter. If cystitis occurs, or calculus develops, the troubles of those conditions are added. The prostate is felt through the rectum to be enlarged, and any nodular outgrowth can be detected. Protrusions into the bladder can rarely be determined with accuracy; but the enlargement generally can be gauged by passing a catheter, and noting the distance it traverses from the membranous part of the urethra, where it can be felt with the finger, till it enters the bladder, when the urine begins to flow. When the cystoscope can be passed nodular elevations may be seen.

Treatment.—In the early stages great comfort is obtained by regulating the urine; fluid is drunk copiously in the early part of the day, and little or none towards evening; in this way the urine is passed early, and the bladder does not require to be emptied during the night. When urine becomes lodged in the bladder, or passed with great difficulty, it must be removed by catheter. The coudé (or bicoudé) pattern is the most convenient; and only those which can readily be kept aseptic should be selected (vulcanite, or gum-elastic polished inside as well as outside). They should be passed with great gentleness, and used with stringent aseptic precautions, stored in saturated solution of boracic acid, and sterilised from time to time in steam or formalin vapour. If acute retention occurs it should be treated by surgical means (p. 479).

Radical treatment is removal of the prostate (**prostatectomy**); after which, although part of the urethra is often torn away, the sphincter of the bladder injured, and cystitis may have previously been present, excellent functional results have been obtained. The most generally convenient route is by *suprapubic* cystotomy. The mucous membrane over the prostate is cut through on one side with scissors, the finger inserted into the loose surrounding "sheath," and the prostate shelled out of both sides, usually with ease. Bleeding is at first considerable; but it soon stops, and seldom causes much subsequent trouble. The bladder should be drained for a week or so with a wide and short rubber tube, and afterwards allowed to close; if there is cystitis, however, drainage should be continued till marked improvement has taken place. The prostate may be removed by the *perineal* route, through an incision curved away from the anus; the soft parts being retracted and the gland shelled out of its sheath. In this way it is sometimes possible to leave the urethra intact. To facilitate removal it may be hooked down into the wound with a curved retractor passed into the bladder. Some operators prefer, for this purpose, to open the bladder suprapubically as well, and to use the fingers of one hand to press the prostate down, while the other is enucleating it through the perineal wound (*combined prostatectomy*).

The small, hard hypertrophic prostates can seldom be shelled out, but they may be *resected piecemeal* with nibbling forceps, and usually more efficiently by the perineal route.

Palliative Operations.—Before prostatectomy was generally adopted, attempts were made, with varying success, to effect diminution of the prostate by physiological means, viz. by *castration*, or by resection of part of the vas deferens (*vasectomy*). The results were so uncertain, and in some instances so deleterious, mentally and physically, that those procedures are now generally abandoned. With the same object the gland has been treated by *cautery* (*Bottini's operation*), applied with an electro-cautery through the urethra; but this also is of little value compared with prostatectomy. If radical operation is contra-indicated, or refused, and catheterisation becomes difficult, or cystitis profound, a permanent fistula to drain the bladder may be made either above the pubis or in the perineum.

FEMALE GENITAL ORGANS.

PUDENDA—VAGINA.

Abnormalities.—The clitoris may be developed to such an extent that it resembles a penis with hypospadias. When this is combined with adhesion of the labia and hernia of the ovaries the condition of false *female hermaphrodism* is produced (*see also* p. 487).

Swellings in the labia comprise:—*Hernia*, generally congenital, and presenting the usual signs (reducibility, etc.); it sometimes contains ovaries. *Hydrocele* in the canal of Nuck, either free or encysted (rare): fluctuant, and occasionally reducible, and extending up towards the ring. *Varicocele*, and superficial *angioma*: reducible on recumbent position or pressure. *Abscess* of the labium: fluctuant and extremely tender. *Hæmatoma*, following injury: with extensive ecchymosis. *Tumours* (lipoma, fibroma, epithelioma): of solid consistence, and in malignant cases implicating the glands. *Cysts* (from retention of the secretion of *Bartholin's glands*, and from *ecchinococcus*): producing fluctuant and well-defined swellings.

Vulvitis is generally due to gonorrhœa, but may occur after simple irritation, especially in children. It is sometimes accompanied by abscess, and may be followed by atresia of the labia. It is *treated* by rest, soothing applications, and frequent cleansing.

Gonorrhœa in the female is sometimes **acute**. It affects the vulva, urethra, cervix, and less markedly the vagina. There is œdematous swelling of the labia, enlargement and tenderness of Bartholin's glands, purulent discharge, painful micturition, general pelvic discomfort, and feverishness. More commonly it is **chronic**; and is often *latent*, and only becomes revealed on congestion of some kind, such as menstruation, and especially childbirth. It is located chiefly in the cervix of the uterus, Bartholin's glands, and sometimes in the urethra; it is thus not easily accessible for treatment, and so remains very intractable. The inflammation invades the uterus, and from that it commonly spreads to the Fallopian tubes (*salpingitis*), where it may give rise to suppuration (*pyosalpinx*) or closure of the tube or ostium. Or it may invade the peritoneum (*pelvic peritonitis—perimetritis*); the cellular tissue, broad ligament, etc. (*pelvic cellulitis—parametritis*); or the ovary. Gonococci may be found in the pus in any of these localities; but in the vaginal discharge they are scarce, and often difficult to detect.

The **symptoms** frequently come on in a woman previously robust in the course of a week or two. These are chiefly dysmenorrhœa, sometimes combined with profuse hæmorrhage; persistent pelvic pains, increased by exertion, and confining the patient to the couch; dyspepsia, wasting, and general invalidism. There is generally a slight opalescent discharge from the os. The patient is usually sterile; or pregnancy, if it supervenes, may be followed by puerperal septicæmia.

Treatment.—*Acute* gonorrhœa is treated in general as in the male; and the vagina is douched frequently with warm lotions, always with the aid of a dilating speculum, if it does not cause too much irritation; and copious urination is encouraged. In the *chronic* form douching is less effective, but it should be persisted with. In addition, the cervix and the urethra, if infected, should be swabbed with nitrate of silver on a probe, daily at first, then twice weekly. The complications usually fall within the domain of gynæcology; but they must be treated on general surgical principles, if met with in the course of other conditions.

Fistulæ between the vagina and bladder or rectum generally arise from rupture of the perineum in childbirth; occasionally from ulceration due to suppuration or malignant disease. *Vesico-vaginal* fistula is the most common: it causes incontinence of urine, and sometimes cystitis. *Recto-vaginal* fistula causes incontinence of fæces, and gives rise to great discomfort and distress. They should be repaired as soon as possible by plastic operations.

The **urethra** is sometimes the seat of small vascular *caruncles*. They are extremely sensitive, and give rise to frequent and painful micturition; and sometimes to spasm (*vaginismus*) on coitus. They should be removed by the cautery.

UTERUS.

Tumours.—The commonest are *myomata* (“*fibroids*”). They arise in the uterine wall, and either come to the surface and develop there, (*a*) on the peritoneal aspect (*subserous*), or (*b*) in the interior (*submucous*), or (*c*) remain *interstitial*. The chief **symptoms** are hæmorrhage, dysmenorrhœa, leucorrhœa, or sterility. Large tumours may exert pressure on the bowels, causing constipation or obstruction; on the veins, causing congestion and œdema; on the nerves, causing neuralgia; or on the bladder or urethra, causing “irritation” or retention of urine.

Diagnosis from ovarian swellings, etc. (*vide* Ovary).

Treatment.—Isolated tumours should be removed separately; internal ones through the vagina, by means of a snare; subserous ones through an abdominal incision. For multiple tumours or large interstitial growths, the uterus should be amputated above the cervix (*supravaginal hysterectomy*).

Malignant.—**Cancer** begins either in the cervix or in the body of the uterus. That of the *cervix* (carcinoma or epithelioma) is common after the age of thirty-five, and occurs most frequently in women who have borne many children and suffered from lacerations of the cervix. The first **symptom** is hæmorrhage, consisting often of no more than a slightly blood-stained discharge, which appears from time to time, after the menopause, or between the menstrual periods. Less frequently it begins with a severe flooding, followed by slighter hæmorrhages. Gradually an offensive discharge makes its appearance, and the hæmorrhages become more frequent. Pain is generally absent until the later stages, when infiltration and adhesions have taken place. On examination by palpation, the os at first is felt soft and patulous, and the slightest touch causes bleeding; with the speculum, the cervix is seen to be slightly eroded and everted. In cases of doubt, or when this condition is unaccounted for by any other obvious cause, and does not heal under warm douching and attention to the general health within a short time, a piece should be excised for examination. In the later stages the cervix becomes covered with a nodular growth (*cauliflower excrescence*); and the disease spreads to the body of the uterus, the vaginal walls, lymphatics, broad ligament, bladder, and rectum—ulceration into the latter two of which produces fistulæ.

Carcinoma of the body is much less common; *sarcoma* and *chorion-epithelioma* (following abortion or normal labour) still less so. In these there is uniform enlargement of the uterus (especially in the last condition, where the growth is sometimes extremely rapid); profuse hæmorrhage, and foul discharge.

Diagnosis.—From endometritis of simple or gonorrhœal origin; syphilitic ulceration; or sloughing myoma.

Treatment.—In the very early stage, when the disease is quite superficial and confined to the cervix, that part may be amputated (*supravaginal amputation*), though a more radical removal is safer. Beyond that stage, and when it has existed for more than a few months, the uterus must be removed, (*hysterectomy*) either (*a*) through the vagina; or (*b*) by abdominal incision, the glands and infiltrations being exposed by this means, and the whole organ removed (*panhysterectomy*), with less risk to the ureter than in the former method. To obviate secondary hæmorrhage, it is safer to tie all the larger vessels twice.

FALLOPIAN TUBES.

Salpingitis occurs frequently in a simple form from chills and imprudences during menstruation. The *severe* form arises from gonorrhœa, or other uterine infections (*e.g.* from the passage of an unclean instrument, "puerperal fever," etc.). The **symptoms** in this form are mainly dysmenorrhœa, pain on movement or straining, dyspepsia, diarrhœa or constipation, wasting, and general ill-health. It may be **diagnosed** from chronic appendicitis (with which it is sometimes associated), by the more common occurrence of menorrhagia, and the absence of such constant abdominal tenderness.

Treatment in the simple form consists of rest and warm vaginal douching. Where suppuration takes place the affected tube should be resected as soon as possible.

Tubercular disease of the tubes presents much the same characters; it is treated by removal.

OVARY.

Solid tumours comprise *fibro-myoma*, *carcinoma*, and *sarcoma*, but they are rare.

Cysts are very common. They arise in the ovary itself or in the parovarium.

(*a*) **Multilocular ovarian cysts** (the most common variety) are produced by degeneration of the Graafian follicles; and generally consist of one chief cyst containing mucoid fluid, and numerous subsidiary cysts within a common cyst-wall. The ovary forms part of the cyst, and is generally completely atrophied; and the tube is stretched out on its surface.

(*b*) **Dermoid cysts** of the ovary, containing partially developed structures (hair, teeth, bone, etc.), are sometimes met with.

(*c*) **Unilocular parovarian cysts** originate in the remains of the Wolffian body; and form large, single, thin-walled cysts containing clear watery fluid. They lie within the layers of the broad ligament, and the tube is stretched over the surface; but the ovary may be separable from it, and does not form part of the tumour.

(*d*) **Papillomatous cysts** are formed in the region of the hilum (*paroöphoron*). The inner walls are covered with villi, from which spring numerous outgrowths. These cysts sometimes grow rapidly; and bursting through their capsule, become implanted on the peritoneal surfaces, where they proliferate.

The **chief symptoms** of the larger cysts are those of pressure on the adjacent structures (bladder, bowels, diaphragm, blood-vessels, etc.); distension, and discomfort. Occasionally *torsion of the pedicle* takes place, and this leads to strangulation of the tumour, with symptoms resembling those of ileus or peritonitis. Percussion shows dulness in the middle line of the belly, where the tumour comes to the surface, and a tympanitic note in the flanks, where the colon lies between it and the abdominal walls; and this is not altered by change of position.

Diagnosis of ovarian swellings is generally easy; but the recognition of certain conditions which present similar signs, such as *omental* and *retroperitoneal tumours and cysts*, and the differentiation of *ovarian* from *parovarian cysts*, can sometimes only be made after the abdomen is opened. Amongst the **solid** swellings which may be confused with them, *normal pregnancy* presents other general signs of the condition; and in *ectopic* cases there is sometimes a history of abdominal hæmorrhages. In *uterine fibroids* the tumour is continuous with the uterus; in tumours of the *bowel* there is usually chronic obstruction and blood in the stools; in those of the *spleen*, examination of the blood will often show significant signs: in those of the *kidney*, there is generally haematuria. In *phantom* tumours the swelling disappears under narcosis. Of the swellings due to **fluids**, *ascites* shows dulness in the flanks, where the fluid is most dependent, and tympanitic sound where the bowels rise to the surface; and this alters with position. In *hydronephrosis* the urine from one ureter is obstructed; in *distended bladder*, the tumour disappears on catheterisation; and in *distended gall-bladder*, there is generally a history of previous bilious disturbances.

Treatment.—Tumours and cysts are removed by abdominal section ("*ovariotomy*"). Large cysts should never be tapped through the abdominal walls; but they may be reduced in size after the abdomen is opened, by introducing a large trocar to remove the fluid and break up the subsidiary cysts inside. The pedicle is tied with interlacing ligatures of strong silk (sometimes after reducing the thickness by powerful clamps—*histotribes*). Bleeding from adhesions is stopped, and if possible the stump should be covered with peritoneum. In parovarian cysts, the ovary, if not destroyed, may sometimes be left. The opposite ovary should always be examined; all small isolated cysts should be excised or tapped, as much of the sound tissue being left as possible; but if extensively diseased, the entire ovary should be removed (*oöphorectomy*).

CHAPTER X.

DEFORMITIES OF THE LIMBS.

UPPER LIMB.

Cubitus valgus (or **varus**) is exaggeration of the normal deviation of the forearm outwards (or inwards) from the line of the humerus. It is due chiefly to deformities of the lower end of the humerus. It is sometimes congenital, but more often the result of fractures of the lower end, or of either condyle. Only in excessive deformities is any surgical treatment advisable.

Ankylosis and "**flail-joint**" following disease or operations on the elbow, if they cause disablement, are treated by excision or re-excision; or in the latter condition sometimes by producing ankylosis (*arthrodesis*).

Spontaneous dislocation of the wrist (*Madelung's deformity*) is a rare condition where the carpus becomes very freely movable, and is apt to be displaced backwards and twisted round. The radio-carpal joint is generally intact, but the carpus is loosened from the ulna, and the ulna from the radius; there is also usually some volar curvature of the radius. It occurs in adolescents, mostly young women; and is said to be due to relaxation of the capsule and tendons from overwork. *Treatment* consists in fixing the wrist in a strong wristlet, and strengthening the muscles by rest, massage, and exercises.

Club-hand is a rare deformity analogous to club-foot. It is always congenital, and usually connected with absence or maldevelopment of the carpal bones. The chief deviation from normal is in the direction of flexion; but lateral and dorsal displacements are sometimes seen. Surgical treatment is generally of little help; but tenotomy or osteotomy may be sometimes required.

Trigger finger is a condition in which the finger remains flexed on opening the rest of the hand, and on being stretched out with the other hand, flies back to complete extension with a snap. It is due to nodular thickening on the flexor tendons, usually the result of old chronic inflammations. Slight cases are treated by massage; but in more severe cases the tendon-sheath should be opened, and the offending nodule dissected off.

Hammer finger is like hammer toe (*q.v.*), but is much less common: it is sometimes congenital, but is also liable to occur from cicatrices after injuries or burns.

Webbed fingers (and *toes*) are usually hereditary, and often occur in several members of the same family, and are often accompanied by a **variation in the number** of digits. They are separated by incisions made in such a way as to afford a flap for the raw surfaces of each finger; supernumerary digits being amputated if required.

LOWER LIMB.

Congenital dislocation of the hip, though not common, is recognised to be much more frequent than was formerly supposed. It occurs far oftener in female than in male children; and the deformity is usually confined to one side.

Ætiology.—It is ascribed to (*a*) injuries in the uterus, from irregular and exaggerated contractions displacing the femur from its bed; (*b*) antenatal diseases causing atrophy of the joint, or paralysis of the muscles; and (*c*) developmental defects, or hyperplasia of the joint tissues.

Pathological Anatomy.—At birth the head of the femur is immediately above the acetabulum and usually slightly behind it. The acetabulum is never absent, but it may be shallow, or elongated, or filled with fat. The head is either thickened and round, with almost no neck, or long and conical; and the ligamentum teres is lengthened and often thickened. Later, from muscular action and the weight of the body, the head is displaced towards the anterior superior spine, or sometimes on to the ischium. The acetabulum meanwhile becomes flattened and relatively smaller; and the cartilaginous border lies like a flap over the cavity, or projects outwards. No new acetabulum is formed on the ilium, but the surface becomes so smooth that the bone easily glides upon it. The muscles are atrophied, those above the joint shortened, and those below lengthened, while their axes are altered.

Symptoms.—The first evidences are limping, and shortening of the leg; and the trochanter is seen to project. By manipulating the leg with the pelvis fixed, the movements are found to be abnormal; and in thin children the head may be felt rolling on the ilium. The trochanter lies above Nélaton's line; and there is lordosis, and scoliosis towards the affected side, both of which disappear on laying the child on its back. If the child stands on the affected leg, the pelvis (and with it the gluteal fold) hangs at a lower level. In double dislocation these signs are all present, and in addition, there is a more waddling gait, and generally more prominence of the buttocks.

Diagnosis from other conditions. In *rachitic deformity* with lordosis and waddling gait, the bone lies on Nélaton's line, and cannot be moved from the acetabulum. In *coxa vara*, with the trochanter above Nélaton's line, and shortening of the legs, there is inability to abduct them, and no unnatural mobility of the head. In *paralytic dislocation* with displacement similar to that of the congenital form, the head is easily replaced, and there is weakness and flabbiness of the muscles, and paralysis of the legs. In *contractures following tubercular hip disease*, there is want of the free mobility seen in dislocation.

Treatment.—**Palliative** measures may be taken to prevent upward displacement of the femur, by using a firm girdle with a horse-shoe pad to fit over the trochanter. These are of some value in one-sided dislocations, but useless in double ones.

Radical methods consist in enlarging the acetabulum, and replacing the bone. In the so-called "*bloodless*" method (*Lorenz*), reposition is made subcutaneously. After the child is anaesthetised, the legs are extended, and strong traction is made on them, until the head has been drawn down to the level of the acetabulum, and lies on Nélaton's line. All the tense muscles and tendons on the inner side of the thigh are kneaded until they stretch and rupture, or are divided if necessary with a tenotomy knife. The leg is then flexed on the thigh, and the thigh abducted to a right angle with slight inward rotation. The acetabulum is enlarged by a boring movement of the head inwards. The thigh and pelvis are fixed in this position in plaster, which is renewed at intervals of ten weeks or so. At each change of plaster, the leg is brought down a little, until it is parallel with the other; the whole immobilisation lasting about six months. In some cases the great development of the ligamentum teres, and the shallowness of the acetabulum favour redislocation or prevent reposition: in such cases an *open* method is recommended It consists in exposing the parts, opening the capsule, excising the ligamentum teres, and scooping out the acetabulum, till a wide and deep hollow with sharp edges is formed. The tense muscles are stretched or divided; and the operation is concluded, and the after-treatment carried out as in the previous method.

Coxa vara is a deformity caused by the bending of the neck of the femur downwards, sometimes to form an acute angle, or even to touch the shaft; it is often accompanied by displacement downwards of the epiphysis of the head. It occurs about the age of 15; it is more common in males than in females; and it usually affects both hips, one after the other.

Ætiology.—This is still uncertain, but it is probably similar to that of genu valgum in adolescents. Definite signs of rickets as a rule are absent; in some cases evidences of trauma or osteo-arthritis are present, but not constantly.

The **symptoms** are chiefly pain in the hip, limping, and early tiring. The effects of the distortion are to prevent full abduction of the legs, as the great trochanter impinges on the rim of the acetabulum. The patient therefore stands and sits with his legs crossed; and, in well-marked cases, can only walk by crossing one foot in front of the other, and "chasséing" along.

Treatment.—The bone is cut through at the neck; or below the trochanter; or a wedge is removed from the outer side at the latter spot. The legs are put up in a fixed apparatus in the abducted position until union of the bone has taken place.

Genu valgum (*knock-knee*) is a deformity in which the legs, making an angle with the thighs, diverge at the knees; either or both sides being affected. It is more common in males than in females; and is seen most frequently within the first five years of life: though a late form is also met with, occurring about puberty or early adolescence.

Ætiology.—The distortion is attributed to softening and weakening of the bones by rickets and "late rickets," when the weight of the body increases the natural curves, and tends towards pressure-atrophy of the outer condyle.

Pathological Anatomy.—The deformity either lies in the lower end of the femur, where the bone at the inner side, in the vicinity of the metaphysis, grows at the expense of the outer side, so that the internal condyle projects downwards ; or it is due to curvature outwards of the upper part of the tibia : sometimes both conditions are present.

Diagnosis.—Where the femur alone is affected, the deformity disappears when the legs are flexed (*i.e.* the knees and ankles can be brought together at the same time) ; in the other variety it remains, though it usually becomes less prominent. Definite information may be obtained with X-rays.

Complications.—The *patella* and *quadriceps tendon* are sometimes displaced outwards ; they may be replaced by straightening the leg, and if this is not sufficient, by transferring the attachment of the sartorius into the quadriceps tendon. The *ligaments* are often considerably relaxed ; these are improved with correction of the limb, and with massage. Contraction of the *biceps tendon* and *fascia lata* is frequent in well-marked cases ; they can usually be treated by traction, but they sometimes require subcutaneous section. The *synovial membrane* is sometimes chronically inflamed by the movements of non-articular surfaces. *Flat-foot* is sometimes present in addition, when the general tissues are weak and lax ; but in its absence, a compensatory *apparent varus* condition may be induced by the efforts to maintain equilibrium.

Treatment.—General measures for rickets must be adopted in the active stage : and the child must be kept off his feet as much as possible, compatible with his getting plenty of fresh air. As long as the bones are soft, a straight springy splint (*Thomas's*) should be worn on the outer side of the leg and thigh, and the knee bandaged to it : this prevents further deformity, and by its continuous pressure tends sometimes to reduce it. No operative measures should be undertaken for its correction, as long as rickets persists in the active state.

Operative.—When the bone has been consolidated in its false position, the only reliable means of correction is by osteotomy. Of the various methods *Macewen's* is the most useful ; it consists of a linear incision, made from the inner side of the *femur* transversely across the bone above the level of the epiphysis (*i.e.* a finger breadth above the upper limit of the outer condyle), the bone being cut almost through, and then fractured into good position. *Ogston's* method is separation of the internal condyle, by an oblique incision entering the joint, so that it can be slid upwards; there are various modifications of this. In curvature of the *tibia* a wedge may be excised from the inner side. After the first dressing (in three days or so) the limb is put up in a well-fitting plaster case, and the patient is allowed to walk in ten days or a fortnight. The plaster is removed in four or five weeks, when the bone is usually united; in adults repair may take rather longer.

Genu varum (*bow-leg*) is a deformity in the opposite direction to the preceding: it is not so common. It generally affects both legs; and occasionally one leg is the seat of genu valgum and the other of genu varum. It is often accompanied by a compensatory flat-foot.

The general **treatment** is similar; and the special treatment is the opposite to that of genu valgum (*i.e.* splinting and traction towards the inner side of the leg; and incision on the outer part of the bone).

Genu recurvatum (or *retrorsum*) is a condition of over-extension of the knee joint, sometimes of congenital or paralytic origin, but generally the result of old inflammatory disease. It is treated, if necessary, by encasing the limb in leather, poroplastic, or plaster.

Flail-joint of the knee generally results from infantile paralysis. The knee is loose and unable to support the weight of the body. It is treated by resection of the joint, with the object of obtaining a stiff leg (*arthrodesis*).

Curvatures of the tibia ("sabre-shaped," etc.) are treated by excision of a wedge from the convex surfaces. They are frequently accompanied by *exostoses* ("spines") projecting from the muscular surfaces; these should be excised if they cause trouble.

Talipes.—Deformities at the foot and ankle of congenital or acquired origin are classed together as talipes; they comprise *talipes varus*, *valgus*, *equinus*, and *calcaneus*, and *pes cavus*. Congenital talipes is twice as common in males as in females, and is usually double; acquired talipes is generally unilateral. Those cases secondary to nerve lesions are more frequent on the right side; and in those due to paralysis there is usually some coldness and blueness of the limb affected, especially in the earlier stages.

Ætiology. *Congenital* talipes is attributed to (*a*) defects of development of the bones; (*b*) injuries in the uterus; (*c*) compression, from undue contractions, want of amniotic fluid, from intra-uterine or extra-uterine agencies, by which the foot is kept in its fœtal position, or pressed against other structures. The *acquired* forms occur as results of (*d*) fracture, osteomyelitis, burns, myositis, arthritis, or habitual malposition; but most of all from (*e*) lesions of the nervous system, especially *infantile paralysis* (*anterior polyomyelitis*) causing paralysis of one set of muscles, and nervous *irritation* causing spastic contraction of the opposite set.

Talipes varus (*club-foot*) is by far the most common variety; it is generally complicated with a certain amount of retraction of the heel (*equino-varus*). The foot is acutely inverted, the sole sharply curved, the heel is drawn up, and the toes are directed inwards. The patient walks on the outer edge, and in extreme cases on the dorsum of the foot: the skin on this part being thickened, and often provided with a bursa. The ligaments and tendons on the inner side, and the muscles and fasciæ on the plantar aspect, are shortened, and the structures on the opposite sides correspondingly lengthened. The astragalus is always distorted, the neck making an angle with the body, sometimes of considerable acuteness; in addition, the scaphoid is displaced inwards, and touches only at the inner part of the articular surface. In old-standing cases the other bones are apt to be crushed out of shape.

Treatment should be commenced without delay; in the congenital cases immediately after birth, in the acquired forms, as soon as the active cause has subsided. The foot is massaged, gently but persistently twisted outwards, and held in that position for a few minutes at a time; this being repeated twice or thrice a day. If improvement does not follow, the foot should, in addition to these manipulations, be placed in an adjustable splint (*Scarpa's shoe*, or its many modifications), by which it is twisted into place and kept there. Any tight and inextensible structures which prevent reduction may be cut through; this division may include the whole of the soft tissues of the sole, carried out subcutaneously with a tenotomy knife (*Buchanan*), or by an open incision (*Phelps*) with subsequent healing by granulations in the open wound; or it may be confined to any individual tendon (*tenotomy*) (usually the peronei or tibialis anticus), or to the joint capsule or ligaments (*syndesmotomy*). If the tendo Achillis has to be cut, it should be saved as long as possible to afford a *point d'appui* for manipulations. After the first year, when the bones are more ossified, and established in the false shape, these methods are not usually sufficient. When the ossifying centres are quite small, *Ogston's* method is often very satisfactory; it consists in scooping out the centres of the offending bones, crushing the cartilaginous shells into shape, and maintaining the good position by plaster-of-Paris. Or the foot may be twisted into shape without cutting, by a powerful wrench (*osteoclasis*). In the later ages it is often necessary to cut through the neck of the astragalus (*osteotomy*); resect a wedge of the tarsus including the astragalo-scaphoid joint (*tarsectomy*); or excise the astragalus completely (*astragalectomy*). The foot is put up in plaster for four or five weeks in the improved position: and after union has taken place, massage and movements are carried out as before, to ensure a mobile and useful foot. In *paralytic* cases, *tendon transplantation* may be employed; part of the tendo Achillis or the tibialis anticus, being used to reinforce the peronei.

Talipes valgus (*flat-foot*) is sometimes congenital; but much more frequently acquired. A slight degree of flat-foot (*pes planus*) is characteristic of certain races, notably negroes. The deformity consists of flattening of the arch, with some eversion of the foot; but in the acquired form (*static* or "*spurious*" *valgus*, *splay-foot*), the distortion of the ankle is generally less marked.

Ætiology.—The latter form arises in growing boys or girls about the tenth to the twentieth years, from undue growth of the body and increase in weight without corresponding development of muscle; it is more common in those with specially long feet. It is induced by carrying heavy burdens, and standing long on the feet; and is aggravated by any bodily illness which reduces the strength.

Pathological Anatomy.—Weakness of the muscles and tendons of the calf, and the short muscles of the sole, allows the weight to fall on the fasciæ and ligaments, which under those circumstances tend to stretch; the arch flattens out, and the head of the astragalus comes to touch the ground, and even project downwards. This entails subluxation of the joints, stretching of the ligaments, articulation of the various bones on non-articular surfaces, giving rise to some traumatic synovitis; and in the later stages to ankylosis of the various joints.

Symptoms.—The foot is seen to be flat and unnaturally wide; the foot-print shows the whole surface of the sole touching the ground (instead of leaving a hiatus corresponding to the arch of the foot); and the astragalus may be felt projecting in the sole. There is generally pain, referred to the middle of the foot (astragalo-scaphoid joint), to the base of the great toe, the heel, or sometimes to the external malleolus; and there are often painful cramps in the legs at night, and stiffness in the morning. The affected foot also is often colder and bluer than normal. The gait is shambling and without spring; and the feet are kept everted.

Treatment in the early stages consists principally in improving the muscular tone by fresh air, good food, and tonics; rest to the part, tiptoe exercises (at first for one minute repeated twice a day, afterwards for five minutes or more); and massage and douching of the calf muscles. To obviate the pain and discomfort, a cork or rubber *pad* may be worn in the inner side of the sole of the boot; or the arch of the sole may be supported by a plate of spring steel curved to fit it, with a flange on the opposite side to keep it from slipping. When the disease is definitely established, and especially if ankylosis has taken place, the foot may be wrenched into good position with an osteoclast, and fixed in plaster. More satisfactory in many cases is *excision of a wedge* from the inside of the foot (the reverse of the treatment of talipes varus). The after-treatment includes exercises and massage to improve the tone.

Talipes equinus is retention of the foot in plantar-flexion by traction on the tendo Achillis; it is not common in the simple form, but is frequently enough combined with talipes varus and valgus. It occurs sometimes as a result of rheumatic and rheumatoid diseases; and also as compensatory elongation of the lower limb after injuries or disease. In extreme cases the toes may be turned over, so that the weight is borne on the dorsum. It is *treated* by manipulations, tenotomy, or excision of the bones, as required.

Talipes calcaneus is one of the rarer forms: the foot is dorsi-flexed, so that the weight falls on the heel only, while the foot projects upwards, or is occasionally bent acutely down at the anterior part. *Treatment.*—Tenotomy is generally of little use in these cases, as the disease is usually paralytic in origin; but transference of the tendons of the peronei or other muscles to the tendo Achillis sometimes gives good results.

Pes cavus (*pes arcuatus*) is also a rare form; the foot is acutely arched so that the weight is borne on the heel and toes only, the middle part of the sole being off the ground. It is variously accounted for, some saying that it is a result of talipes *equinus*, the flexion being caused by the weight of the body; others attributing it to falling down of the fore part of the foot in talipes *calcaneus*. *Treatment* consists of section of the plantar structures, with tenotomy of the tendo Achillis if necessary.

Hallux valgus is overflexion outwards of the great toe, so that it overlaps or underlies the other toes. In extreme cases there is subluxation of the metatarso-phalangeal joint, and frequently some chronic synovitis. It arises from wearing pointed boots; and it is aggravated by any chronic thickening, especially that due to osteo-arthritis.

Treatment.—It is treated by wearing anatomically-shaped boots, with plenty of room for separation of the toes by pads of lint, "fingers" in the stockings, or braces and straps attached to the toe and heel. Rigid toe-posts in the sole of the boot are apt to cause too much irritation; but sandals with toe-straps should be worn for several months at a time, if circumstances permit. In very severe cases the head of the metatarsal may be excised.

Hallux flexus is flexion of the great toe corresponding to the "hammer" condition affecting the other toes. **Hallux rigidus** is stiffness without flexion.

In-growing toe-nail (a misnomer for *over-growing nail-bed*), usually of the great toe, is caused by wearing narrow-toed boots. The constant pressure causes irritation between the edge of the nail and the skin; and an ulcer forms, which is very painful and difficult to heal.

Treatment.—The chief measures necessary are removal and avoidance of such irritation, by wearing boots with wide enough toes; and disinfection of the ulcerated surface. This is done by repeated washing of the feet with warm water and soap, and bathing them with strong boracic solution, and in the intervals packing the space between the nail and skin with dry boracic lint, which may be fixed in place with adhesive plaster. In old-standing refractory cases, with great exuberance of the skin beside the nail, a wedge of nail and skin, enclosing the ulcerated part, should be removed from the whole length of the nail.

Hammer toe is permanent flexion at one of the phalangeal joints (generally the second), and fixture in this position by shortening of the ligaments and subsequently of the tendons. A bursa frequently forms over the projecting joint, and it is liable to inflammation from injurious pressure.

Treatment.—In slight cases a small tubular metal splint with a continuation along the sole (*Adams's*) should be worn. In the more severe cases, the constricting ligaments and tendons should be cut; and if this fails to give relief, the toe may be amputated.

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